



March 2, 2022

ADDENDUM NO. 2

TO

CITY OF BEAUMONT, TEXAS
PINE STREET SWTP POLYMER SYSTEM AND CHEMICAL STORAGE TANK IMPROVEMENTS
BID No. WU0122-12

THIS ADDENDUM IS ISSUED FOR THE PURPOSE OF AMENDING THE CONTRACT DOCUMENTS FOR THE PINE STREET SWTP POLYMER SYSTEM AND CHEMICAL STORAGE TANK IMPROVEMENTS FOR THE CITY OF BEAUMONT, TEXAS:

The following additions, deletions, modifications, or clarifications shall be made to the appropriate sections of the plans and specifications and shall become part of the Contract Documents.

All bidders are herewith notified of the following additions, deletions, changes, or clarifications to the original Specifications, Contract Documents, and Contract Drawings.

When submitting the bid, bidders MUST acknowledge receipt of this Addendum No. 2 on the appropriate page within the bid specifications.

CLARIFICATIONS

As attached on the following pages.

GENERAL

As attached on the following pages.

END OF ADDENDUM NO. 2

A handwritten signature in blue ink that reads "Amalia Villarreal".

Amalia Villarreal, P.E.
City Engineer

CITY UTILITIES

T 409.866.0026

F 409.861.4836

1350 Langham Road | Beaumont, TX 77707

beaumonttexas.gov



00 91 02 ADDENDUM NUMBER 2

Owner: City of Beaumont
Pine Street SWTP Polymer System and Chemical Storage Tank
Project: Improvements
Project No.: BMT21704 (City Bid No. WU0122-12)
Addendum No. 2
Addendum Date: 3/1/2022

The following additions, deletions, modifications, or clarifications shall be made to the appropriate portions of the Contract Documents. Offerors must acknowledge receipt of this Addendum in the space provided on the Bid Form.

Approved by: Freese and Nichols
Name: Somnath Chilukuri
Date: 3/1/2022



FREESE AND NICHOLS, INC.
TEXAS REGISTERED
ENGINEERING FIRM
F-2144

Addendum Items:

Article 3 – Revision to Specifications
Section 00 01 10 Table of Contents
Section 26 01 26 Testing of Electrical Systems
Section 26 05 00 Common Work Results for Electrical
Section 26 05 23 Control-Voltage Electrical Power Cables
Section 26 05 26 Grounding and Bonding for Electrical Systems
Section 26 05 29 Hangers and Supports for Electrical Systems
Section 26 05 33 Raceways and Boxes for Electrical Systems
Section 26 05 53 Identification for Electrical Systems
Section 26 22 13 Low-Voltage Distribution Transformers
Section 26 24 16 Panelboards

Article 5 – CivCast Questions

Pre-Bid Conference Agenda Sheet

ARTICLE 1 – ADDENDUM

1.01 Amend the Contract Documents

- A. Make the additions, modifications, or deletions to the Contract Documents described in this Addendum.

1.02 Acknowledge Addenda

- A. Acknowledge receipt of this Addendum in the Bid Form submitted for this Project. Failure to acknowledge receipt of this addendum in the Bid Form may render the Bid as non-responsive and serve as the basis for rejecting the Bid.

ARTICLE 2 – BID REQUIREMENTS

2.01 Update Bid Opening Date

- A. Sealed bids shall be delivered to the Owner no later than March 10, 2022 at 2:00 pm.

ARTICLE 3 – SPECIFICATIONS

3.01 00 01 10 Table of Contents

- A. Add the following lines in Division 00:
 - 1. “00 91 01 Addendum Number 1”
 - 2. “00 91 02 Addendum Number 2”
- B. Add the following lines in Division 26:
 - 1. “26 05 00 Common Work Results for Electrical”

3.02 00 11 16 Invitation to Bid

- A. Paragraph 7.01, delete the first sentence and replace with the following:
 - 1. “Sealed Bids must be delivered to the Owner at the address below no later than March 10, 2022 at 2:00 p.m. to be accepted.”

3.03 Division 26 Electrical

- A. Add the following technical specifications in their entirety:
 - 1. 26 01 26 Testing of Electrical Systems
 - 2. 26 05 00 Common Work Results for Electrical
 - 3. 26 05 19 Low Voltage Electrical Power Conductors and Cables
 - 4. 26 05 23 Control-Voltage Electrical Power Cables
 - 5. 26 05 26 Grounding and Bonding for Electrical Systems
 - 6. 26 05 29 Hangers and Supports for Electrical Systems
 - 7. 26 05 33 Raceways and Boxes for Electrical Systems
 - 8. 26 05 53 Identification for Electrical Systems
 - 9. 26 22 13 Low-Voltage Distribution Transformers

10. 26 24 16 Panelboards

ARTICLE 4 – DRAWINGS [NOT USED]

ARTICLE 5 – CIVCAST QUESTIONS

5.01 Questions and responses provided through CIVCAST through February 28, 2022 at 12pm are as follows:

4. Are electrical specs available for this project? I see them only mentioned in the table of contents

Response – Yes, Division 26 Electrical specifications are provided as part of Addendum No. 2.

END OF ADDENDUM NO. 2

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01 26 00	Change Management
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01 33 00	Document Management
01 33 01	Document Register
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01 33 04	Operation and Maintenance Data
01 33 05	Construction Progress Schedule
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26 01 26	Testing of Electrical Systems
26 05 00	Common Work Results for Electrical

Section	Title
26 05 19	Low Voltage Electrical Power Conductors and Cables
26 05 23	Control-Voltage Electrical Power Cables
26 05 26	Grounding and Bonding for Electrical Systems
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26 24 16	Panelboards
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44 42 73	Chemical Storage Tanks
Division 46	Water & Wastewater Equipment
46 33 41	Chemical Feed Pumps

END OF SECTION

00 11 16 INVITATION TO BID

ARTICLE 1 – GENERAL NOTICE

- 1.01 The City of Beaumont (Owner) is requesting Bids for the construction of the following Project:
Pine Street SWTP Polymer System and Chemical Storage Tank Improvements
Bid No. WU0122-12
- 1.02 Description of the Work
- A. This project consists of flood protection improvements at the water treatment plant, including, but not limited to:
1. Modifications to the Bulk Chemical Storage Facility including structural expansion, demolition, new storage tanks, pumps, piping, and associated electrical and instrumentation improvements
 2. Replacement of ammonia day tank in Chemical Feed Building
 3. Modifications to the polymer storage and feed system including demolition of existing storage drums and scales, replacement of feed pumps, and addition of flow meters, and associated piping, electrical, and instrumentation improvements.
 4. Ramp modifications at Chemical Feed Building
- 1.03 The Project is to be substantially complete and ready for operation within 270 days from authorization to proceed. The Project is to be complete and eligible for final payment 60 days after the date for Substantial Completion.

ARTICLE 2 – EXAMINATION AND PURCHASE OF DOCUMENTS

- 2.01 Advertisement and bidding information for the Project can be found at the following procurement or the City's website:
www.civcastusa.com
<https://beaumonttexas.gov/departments/purchasing/bid-information/>
- 2.02 Prospective Offerors must register with the procurement website as a plan holder, even if the Contract Documents are obtained from a plan room or other site. All official notifications, Addenda, and other documents will be offered only through the procurement website.
- 2.03 The Contract Documents may be downloaded from the procurement website by prospective Offerors registered as plan holders. Offerors are responsible for ensuring that a complete set of documents, as defined in Section 00 52 13 "Agreement," are used in the preparation of their Bids. The documents are made available for the sole purpose of obtaining Bids for completion of the Project and permission to download does not confer a license or grant permission or authorization for any other use. Authorization to download documents includes the right for Offerors to print documents for their sole use, provided they pay all costs associated with printing or reproduction. Printed documents may not be re-sold under any circumstances.
- 2.04 The procurement website will be updated periodically with Addenda, lists of interested parties, reports, or other information relevant to submitting a Bid for the Project.

- 2.05 Printed copies of the Contract Documents, Technical Data, and other information may be examined free of charge at the following address:

City of Beaumont
1350 Langham Road
Beaumont, TX 77707
Hours Available for Viewing: 8 AM to 5 PM

ARTICLE 3 – PRE-BID CONFERENCE

- 3.01 A mandatory pre-bid conference for the Project will be held on February 23, 2022 at 1:30 PM at the following location:

City of Beaumont
801 Main Street
1st Floor Conference Room
Beaumont, TX 77701

ARTICLE 4 – SITE TOUR

- 4.01 A tour of the Site will be held the afternoon of the pre-bid conference. Prospective Offerors attending this site tour are required to arrange their own transportation to the Site. Maps to the Site will be available at the pre-bid conference.

ARTICLE 5 – QUESTIONS REGARDING BIDDING PROCESS OR SOLICITATION DOCUMENTS

- 5.01 Questions are to be submitted using the question and answer process on the procurement website. Responses to questions posted on the procurement website will be posted for the benefit of all Offerors. A response will be posted for questions submitted until 2:00 p.m. on February 25, 2022.
- 5.02 A response to a question posted on the procurement website that requires modification of the Contract Documents will be made by Addenda. Modifications to the Contract Documents prior to the award of the Contract can only be made by Addenda. Only answers in Addenda posted on the procurement website will be binding. Oral and other interpretations or clarifications will be without legal effect.

ARTICLE 6 – BID SECURITY

- 6.01 Offerors must submit an acceptable Bid Security with their Bids as a guarantee that the Successful Offeror will enter into a contract for the Project with the Owner within 15 days of Notice of Award of the Contract. The Bid Security must be payable to City of Beaumont in the amount of 5 percent of the proposed Contract Price. The Successful Offeror must execute the Contract and bonds on the forms provided in the Contract Documents and provide evidence of insurance as required by the Contract Documents.
- 6.02 Bid Security may be in the form of a bid bond, a cashier's check, or certified check. Checks must be made out to City of Beaumont. The bid bond may be submitted on the form provided in Section 00 43 13 "Bid Bond" or Offerors may provide their surety's standard penal sum bid bond form. The bid bond must reference the Owner and Project by name as identified in this Section.

ARTICLE 7 – DELIVERY OF BIDS

- 7.01 Sealed Bids must be delivered to the Owner at the address below no later than March 10, 2022 at 2:00 p.m. to be accepted. The Bids will be publicly opened and read aloud at this time and place including the names of the Offerors and their Bids. Bids received after this time will be returned unopened. Address Bids to the Owner as follows:

City of Beaumont

Tina Broussard, City Clerk

Attn: Bid – Pine Street SWTP Polymer System and Chemical Storage Tank Improvements [Bid No. WU0122-12]

801 Main Street, Suite 125

Beaumont, TX 77701

ARTICLE 8 – AWARD OF CONTRACT

- 8.01 It is the intent of the Owner to award this Contract to the lowest responsible Offeror. The Owner reserves the right to adopt the most advantageous interpretation of the Bids submitted in the case of ambiguity or lack of clearness in stating bid prices, to reject any or all Bids, and/or waive formalities. Bids will remain subject to acceptance and may not be withdrawn within 90 days from the date on which Bids are opened.

ARTICLE 9 – OTHER CONTRACT REQUIREMENTS

- 9.01 Selected Contractor will be required to pay the prevailing wage rates established for this Project in accordance with the Contract Documents and Tex. Gov't Code Chapter 2258.
- 9.02 Performance, payment, and maintenance bonds will be required for this Project.

END OF SECTION

26 01 26 TESTING OF ELECTRICAL SYSTEMS

1.00 GENERAL

1.01 WORK INCLUDED

- A. Furnish labor, material, equipment and incidentals of an independent testing agency.
- B. These specifications cover the suggested field tests and inspections that are available to assess the suitability for initial energization and final acceptance of electrical power equipment and systems.
- C. The purpose of these specifications is to assure that electrical equipment and systems are operational, are within applicable standards and manufacturer's tolerances, and are installed in accordance with design specifications.
- D. The work specified in these specifications may involve hazardous voltages, materials, operations, and equipment. These specifications do not purport to address all of the safety issues associated with their use. It is the responsibility of the user to review all applicable regulatory limitations prior to the use of these specifications.
- E. Testing shall be inclusive of all low voltage equipment including conductors that are provided under this contract.
- F. Testing shall include all relay protective schemes and operation of the low voltage equipment.

1.02 QUALITY ASSURANCE

- A. Testing Organization:
 - 1. The testing organization shall be an independent, third party entity which can function as an unbiased testing authority, professionally independent of the manufacturers, suppliers, and installers of equipment or systems being evaluated.
 - 2. Testing organization shall be regularly engaged in the testing of electrical equipment devices, installations, and systems.
 - 3. The Testing organization shall use technicians who are regularly employed for testing services.
 - 4. An organization having a designation of NETA Accredited Company issued by the International Electrical Testing Association meets the above criteria.
 - 5. Independent testing agency shall follow all tests and recommendations in NETA Acceptance Testing Specification for all equipment provided.
 - 6. Testing Organization performing the work shall submit appropriate documentation to demonstrate that it satisfactorily complies with these requirements.
 - 7. Acceptable Testing Agencies:
 - a. National Field Services
 - b. Real Power Technologies
 - c. Shermco Industries
 - d. Electrical Power Systems

8. Testing Personnel
 - a. Technicians performing these electrical tests and inspections shall be trained and experienced concerning the apparatus and systems being evaluated. These individuals shall be capable of conducting the tests in a safe manner and with complete knowledge of the hazards involved. They must evaluate the test data and make a judgment on the serviceability of the specific equipment.
 - b. Technicians shall be certified in accordance with ANSI/NETA ETT, Standard for Certification of Electrical Testing Technicians. Each on-site crew leader shall hold a current certification, Level 3 or higher, in electrical testing.

1.03 SUBMITTALS

Submittals shall be in accordance with Section 01 33 00, "Document Management" and shall include:

A. ELECTRICAL QUALIFICATIONS & LIST OF TEST SUBMITTAL

1. 60 days prior to any testing taking place, Contractor shall submit to the Owner/Engineer the name of the testing agency; a list of all tests to be conducted shall also be submitted at this same time. No testing shall take place until this has been submitted and approved by the Engineer.

B. ELECTRICAL TESTING PLAN

1. A minimum of two (2) weeks before testing is to take place, Contractor shall submit a detailed testing plan of the different configurations to be tested for the Owner's and Engineer's approval.

C. ELECTRICAL TESTING REPORT

1. A written report shall be submitted by the testing agency performing installation checks, operation and testing of the low voltage equipment. This report shall certify that
 - a. The equipment has been properly installed
 - b. Is in accurate alignment
 - c. Meets the acceptance testing specifications of NETA and the equipment manufacturer.
2. Provide a detailed list of all tests that were performed and the test results as part of the Electrical Testing Report.
3. Electrical Testing Report(s) shall be submitted to Engineer for approval no later than one week after testing has been conducted.

1.04 STANDARDS

- A. The applicable provisions of the following standards shall apply as if written here in their entirety:
 1. American National Standards Institute (ANSI)
 2. Association of Edison Illuminating Companies (AEIC)
 3. Electrical Apparatus Service Association (EASA)
 4. American Standards for Testing and Materials (ASTM)
 5. Institute of Electrical and Electronic Engineers (IEEE)
 6. Insulated Cable Engineers Association (ICEA)

7. National Electrical Manufacturers Association (NEMA)
8. International Electrical Testing Association (NETA)
9. National Fire Protection Association (NFPA)
10. Occupational Safety and Health Administration (OSHA)
11. State and local codes and ordinances
12. Underwriters Laboratories, Inc. (UL)

2.00 EXECUTION

2.01 GENERAL

- A. All testing shall be witnessed by the Owner's Representative. Types of equipment required to be tested by these specifications shall include but not be limited to the following:
 1. Low Voltage Cables
 2. Switchboards
 3. Motor Control Centers
 4. Generator
 5. Automatic Transfer Switch
 6. Variable Frequency Drives
 7. Grounding
- B. At a minimum, unless indicated otherwise, all testing shall be in accordance with the manufacturer's recommendations for energization and start-up of the equipment.
- C. Testing shall include a complete functionality testing of electrical equipment under all the different operating parameters identified by the OWNER and ENGINEER.
- D. Electrical testing instrument calibration shall be as indicated in ANSI/NEMA ATS-2017.

2.02 TEST REPORT

- A. The test report shall include the following:
 1. Summary of the project.
 2. Description of equipment tested.
 3. Description of tests.
 4. Test data.
 5. Analysis and recommendations.
- B. Test data records shall include the following minimum requirements:
 1. Identification of the testing organization.
 2. Equipment identification.
 3. Nameplate data.
 4. Humidity, temperature, and other conditions that may affect the results of the tests and/or calibrations.
 5. Date of inspections, test, maintenance, and/or calibrations
 6. Identification of the testing technician.
 7. Identification of inspections, tests, maintenance, and/or calibrations to be permed and recorded.
 8. Identification of expected results when calibrations are to be performed.
 9. Identification of as-found and as-left results, as applicable.

- 10. Identification of all test results outside of specified tolerances.
- 11. Sufficient spaces to allow all results and comments to be indicated.
- C. The testing organization shall furnish a copy or copies of the complete test report as specified.

2.03 TEST DECAL

- A. The testing organization shall affix a test decal on the exterior of equipment or equipment enclosure of protective devices after performing electrical tests.
- B. The test decal shall be color-coded to communicate the condition of maintenance for the protective device. Color scheme for condition of maintenance of overcurrent protective device shall be:
 - 1. White: electrically and mechanically acceptable.
 - 2. Yellow: minor deficiency not affecting fault detection and operation, but minor electrical or mechanical condition exists.
 - 3. Red: deficiency exists affecting performance, not suitable for service.
- C. The decal shall include:
 - 1. Testing organization
 - 2. Project identifier
 - 3. Test date
 - 4. Technician identifier

2.04 POWER SYSTEM TESTING

- A. CONTRACTOR shall test the operation of the power distribution system, i.e. transformers, automatic throw over, double throw disconnect switches, 480V switchboards, etc., for the various possible system configurations under load conditions.
- B. Testing shall include, but not be limited to the following:
 - 1. Normal power from Utility Source 1
 - 2. Back-up power from Source 2
- C. CONTRACTOR shall submit a detailed testing plan of the different configurations to be tested for the Owner's and Engineer's approval.

END OF SECTION

26 05 00 COMMON WORK RESULTS FOR ELECTRICAL

1.00 GENERAL

1.01 WORK INCLUDED

- A. Furnish labor, materials, equipment and incidentals necessary for complete and operational electrical systems, as specified herein.
- B. This Section, as well as Division 1, concerns all other Sections in Division 26 shall be considered a part of each of those Sections as if written in their entirety.
- C. Temporary utilities may need to include generator power for outages, depending on the contractors' means and methods of connecting to existing power equipment. Contractor shall provide electrical testing and inspection services for temporary connections to existing MCC. Fusing for temporary equipment shall be coordinated with upstream devices to assure the fuses will terminate before interrupting electrical service to plant process equipment.
- D. Electrical outages must be coordinated with Treatment Operations, as well as the Electrical, Instrumentation and Inspections Divisions.
 - 1. Shut down sequencing shall be coordinated by the contractor and if a generator is required to power equipment to maintain treatment service, contractor shall be responsible to provide the generator, fuel, and conductors required to keep the plant operational.

1.02 QUALITY ASSURANCE

A. ELECTRICAL CONTRACTORS' QUALIFICATIONS

- 1. Use adequate numbers of skilled workmen, trained and experienced in their crafts, and who are familiar with the specifications and methods of performing the work in this Division. A licensed Journeyman shall be on site at all times when electrical work is being performed. Electrical work shall be performed under the direct supervision of a Master Electrician who holds a valid license in the State of Texas. The Contractor shall provide a monthly report to the Owner/Engineer for review stating that the Master Electrician has been to the job site and thoroughly reviewed the work. The report shall be signed by the Master Electrician and include the data and time the Master Electrician was on site.
- 2. Contractor must have experience with performing electrical work within wastewater treatment plant.

B. WORKMANSHIP

- 1. Work shall be performed in accordance with quality, commercial practices. The appearance of finished work shall be of equal importance with its operation.
- 2. Materials and equipment shall be installed based upon the actual dimensions and conditions at the project site. Locations for materials or equipment requiring an exact fit shall be field measured.

1.03 SUBMITTALS

- A. Submittals shall be in accordance with Section 01 33 00, Document Management and shall include:
1. Submittals shall be submitted separated by specification section. Combined submittals will not be reviewed. Submittal will be marked not approved, revise and resubmit.
 2. Incomplete submittals will not be reviewed and will be marked revise and resubmit.
 3. Resubmittals shall be marked with a red strike through for the items removed from the submittal and clouded with the items added to the submittal.
 4. **Submittals shall be marked to track changes between resubmittals.**
 5. Component catalog number and manufacturing data sheet, indicating pertinent data and identifying each component by the item number and nomenclature as specified.
 6. Component drawings showing dimensions, mounting, and external connection details in AutoCAD format.
 7. Operation and maintenance manuals shall contain the shop drawings, submittals, spare part lists, schematics, project specific final wiring diagrams with any changes made during start-up and maintenance procedures.
 8. Unless other additional information is required by the detailed equipment specifications, the following information shall be included for motors:
 - a. Motor identification number and nomenclature as specified
 - b. Make and motor type
 - c. Brake horsepower of the motor
 - d. Locked rotor current at full load
 - e. Motor efficiency at full load (3-phase motors only)
 - f. Starting torque
 - g. Method of insulating and impregnating motor coils (3-phase only)
 - h. Speed of the motor at full torque
 - i. Full load current
 - j. Service factor
 - k. Motor temperature rise measured by resistance over 40 degrees C ambient
 9. The Contractor shall provide a monthly report to the Owner/Engineer for review stating that the Master Electrician has been to the job site and thoroughly reviewed the work. The report shall be signed by the Master Electrician and include the data and time the Master Electrician was on site.
 10. The Contractor shall:
 - a. Prepare, and keep up-to-date, the Record Drawings and detailed construction drawings.

- b. Record the exact locations of each of these differences, sizes and details of the Construction Work as executed, with cross-references to and other requirements on the Record Drawings.
- c. Keep the Record Drawings on the Work Site;
- d. Upon completion of the Work, or at such other time as may be determined by the Engineer, submit the Record Drawings and copies to the Owner's Representative in accordance with the Owner's Requirements.
- e. Underground Interference drawing showing all underground duct banks, ground rods, ground conductors, pipes, piers, vaults, manholes, pull boxes, etc. that clearly identifies the location and routing of these systems. All interferences shall be brought to the Engineer's attention.
- f. Provide revised drawings in AutoCAD noting any changes made to equipment during start-up.

1.04 STANDARDS

- A. Electrical work shall be executed in accordance with local, State and national codes, ordinances and regulations which have jurisdiction or authority over the work. If the standards and codes conflict with each other, the most stringent shall apply. The applicable provisions of the following standard shall apply as if written here in their entirety:

National Electrical Manufacturer Association (NEMA)

American Society for Testing and Materials (ASTM)

National Fire Protection Association (NFPA)

National Electrical Safety Code (NESC)

Institute of Electrical and Electronic Engineers (IEEE)

National Electrical Code (NEC)

Underwriters Laboratories (UL)

American National Standards Institute (ANSI)

Uniform Building Code (UBC)

Occupational Safety and Health Administration (OSHA)

Local utility companies

Local Electrical Ordinance

Rural Electrification Association (REA)

Insulated Power Cable Engineers Association (IPCEA)

International Electrical Testing Association (NETA)

National Electrical Contractors Association (NECA)

Association Edison Illuminating Companies (AEIC)

Texas Commission on Environmental Quality (TCEQ)

Environmental Protection Agency (EPA)

International Electrotechnical Commission (IEC)

1.05 DELIVERY AND STORAGE

- A. Follow the Manufacturer's directions for the delivery, storage and handling of equipment and materials.
- B. Tightly cover equipment and materials and protect it from dirt, water, chemical or mechanical injury and theft.
- C. Major electrical equipment shall be stored indoors and space heaters energized where applicable. Equipment that will be stored indoors for an extended period of time and that do not have space heaters shall have a 100 watt incandescent light placed in it and energized to eliminate the build-up of condensation in the equipment.
- D. Coordinate with equipment manufacturer for storage requirements.
- E. Damaged equipment shall not be acceptable.
- F. Upon installation, protect the materials until the work is completed and accepted by the Owner.

1.06 JOB CONDITIONS

- A. Permits, licenses and inspections shall be secured and paid for as required by law for the completion of the work. Certificates of approval shall be secured, paid for, and delivered to the Owner before receiving the final acceptance of the work.
- B. The location of materials, equipment, devices and appliances indicated are approximate and subject to revisions at the time the work is installed. Final location shall be as proposed by the Contractor and approved by the Engineer.
- C. Should project conditions require any rearrangement of work, or if equipment or accessories can be installed better than the general arrangement of work on the plans, the Contractor shall prepare and submit plans of the proposed rearrangement for the Engineer's review and approval.

- D. Motor Horsepower ratings identified are anticipated ratings. If the actual equipment is a different size, the contractor shall provide the appropriate wiring, conduit, over current protection, starters and accessories for a complete and working system at no additional cost to the owner.
- E. All enclosures for equipment unless specifically identified otherwise shall be NEMA 12 for indoor air conditioned areas. NEMA 4X 316 stainless steel enclosures for indoor ventilated areas; or NEMA 4, FRP for rooms housing Chlorine; or NEMA 4X, 316 stainless steel for exterior applications and all other locations.
- F. Contractor is required to abide by the Owners Construction Safety and Health Program.
- G. 36" of work clearance must be maintained around equipment.

2.00 PRODUCTS

2.01 MATERIALS

- A. Supplemental or alternative materials supplied and installed by the contractor shall be approved prior to installation.
- B. Materials installed without pre-approval, through the submittals process, shall be removed from the job site and replaced at no additional cost to the owner. No exceptions.
- C. Discrepancies between the plans and specifications shall be addressed prior to bidding the project, otherwise the most expensive of the two options shall be assumed.

3.00 EXECUTION

3.01 INSTALLATION

- A. Maintain the waterproof integrity of conduit penetrations through the roof, exterior walls and floors.
- B. Install steel reinforced concrete foundations below floor mounted switchboards, panelboards, motor control centers, transformers, and other floor mounted electrical equipment. Concrete foundations shall not be less than 4" high. Neatly chamfer top edges. Concrete foundations shall be 4" wider and 4" longer than the base of the equipment being installed. Concrete shall be in accordance with Division 03, and shall be reinforced with a minimum of 6" x 6" #6 welded wire mesh.
- C. Route all conduits parallel to building lines, columns, or steel route conduits near to columns and roof beams.
- D. Raceways penetrating an air conditioned space shall be sealed to prevent outside moisture from passing into enclosures or into air conditioned space.
- E. Enclosures located outside shall not be penetrated from the top.
- F. Details indicated on the drawings and identified in the specifications may not be identified on the drawings in all required locations. Contractor shall request clarification where uncertain.

3.02 CUTTING AND PATCHING

- A. Provide adequate support during cutting operations to prevent any damage to the affected masonry. Where openings are cut through masonry walls, provide lintels or structural supports to protect the remaining masonry. The cutting of structural members shall not be permitted without the specific written approval of the Engineer.

3.03 PAINTING

- A. Painting shall be in accordance with Division 09. Maintain the original factory finish on material and equipment installed, unless specifically indicated on the plans or specifications. If the finish is marred in transit or during installation, re-finish to a neat, workmanlike appearance. Leave equipment and raceway systems clean and free of grease, dirt, rust, and in a suitable condition for painting.

3.04 EXCAVATION, TRENCHING, BACKFILLING AND GRADING

- A. Prior to any excavation or trenching, notify the Owner's representative, utility companies and Owner's facilities department. Allow sufficient time for utilities to be located prior to excavation to avoid disruption of services. Provide a minimum of 72 hours written notice to the Owner prior to trenching or excavation. Do not proceed with trenching or excavation until authorized by the Owner. Utilities or services which are damaged, which are identified prior to excavation or trenching, or where confirmation by utility companies has not been obtained verifying that utilities are marked, shall be repaired to operable condition immediately, at no cost to the Owner.
- B. Barricade open trenches and excavations for the entire duration of the project. Barricades for excavations shall have warning lights maintained during hours of darkness. Trenches shall be marked with warning tape, or access to trenches shall be prohibited with readily identifiable sawhorses, warning tape or other acceptable means. Barriers shall be illuminated or recognizable during hours of darkness. Barriers and tape shall be properly maintained at all times.
- C. Protect all adjacent work, structures and properties. Damage to adjacent work, structures or properties shall be repaired, or the cost of repair reimbursed in full.
- D. All construction areas shall be finally graded as indicated on the contract documents, or to the conditions of the site prior to construction. Grading shall bring the site back to the existing conditions as close as practical. Turfed areas shall be sodded, or hydro-mulched with matching turf. Landscaping shall be replaced with identical shrubbery, ground cover, or plants as existed. Contractor shall be responsible for maintaining water on new turf and landscaping until established. If new turf and landscaping is impractical due to weather conditions, contractor shall provide satisfactory arrangements to have turf and landscaping furnished and installed at the earliest opportunity thereafter. Provide a 90-day warranty on new turf and landscaping.
- E. Determine if irrigation systems exist prior to trenching and excavation. Obtain record or as-built drawings and locate control wiring and pressure main branches and devices. Determine by actual operation that systems are functional and repair or replace damaged systems to their original condition prior to beginning construction.
- F. In cases where high voltage ductbanks may exist, Contractor shall employ safe drilling/excavating techniques such as vacuum excavation, etc.

3.05 LOCKING OF ELECTRICAL FACILITIES

- A. Install locks immediately upon the installation of the electrical facility. Provide padlocks for exterior electrical facilities subject to unauthorized entry. Furnish the Owner with two (2) keys per lock up to a quantity of 10 keys. Furnish locks to match the Owner's locking system.

3.06 CLEAN AND ADJUST

- A. Remove shipping labels, dirt, paint, grease, and stains from equipment. Remove debris as it accumulates. Upon completion of work, clean electrical equipment and the entire electrical installation.

END OF SECTION

26 05 19 LOW VOLTAGE POWER CONDUCTORS & CABLES

1.00 GENERAL

1.01 WORK INCLUDED

- A. Furnish labor, materials, equipment and incidentals necessary to install 600 volt wires and cables. Electrical work shall be in accordance with Section 26 05 00, Common Work Results for Electrical.
- B. Work shall include building wire, cable, wiring connections and terminations, and modular wiring systems.

1.02 QUALITY ASSURANCE: TESTING

- A. Megger test circuits for continuity and ground. Verify phasing at connection points. Torque test conductor connections and terminations to the Manufacturer's recommended values. Megger tests shall be performed by a third party testing company with a minimum of 10 years experience.
- B. Testing Agency's Qualifications: Member company of NETA
 - 1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

1.03 SUBMITTALS

Submittals shall be in accordance with Section 01 33 00, Document Management and shall include:

- A. Shop drawing
- B. Certified test reports
- C. Warranty
 - 1. The manufacturer shall include a two year warranty on materials provided.

1.04 STANDARDS

- A. The applicable provisions of the following standards shall apply as if written here in their entirety:

ICEA S-19-81/NEMA WC-3	Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy
ICEA S-61-402/NEMA WC-5	Thermoplastic-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy
UL's Wire and Cable Marking and Application Guide 2016	

1.05 DELIVERY AND STORAGE

Deliver cable and wire to the project site in the original packages. Conductors with damaged insulation or exposed nylon jacketing shall not be permitted.

2.00 PRODUCTS

2.01 CONDUCTORS AND CABLES

- A. CONDUCTORS: Soft-drawn, annealed tinned copper with a conductivity of not less than that of 98% pure copper bearing the U.L. label. The minimal size shall be #12 unless specified otherwise on the plans. Conductors #12 or larger shall be stranded. Utilize single conductors. Copper conductors shall comply with ASTM B 3 for bare annealed copper and with ASTM B8 for stranded conductors.
- B. SINGLE CONDUCTORS: Tinned copper conductor with thermoplastic insulation rated at 600 volts and insulated with type XHHW-2 insulation. Wire shall be water tank tested and approved as machine tool wire, in accordance with National Machine Tool Builders Association. Wire in light fixture channels and other special locations shall be as specifically noted for temperature in NEC Article 300. Wire shall be manufactured by Southwire, Okonite, General Cable, Houston Wire & Cable or approved equal.

2.02 WIRE CONNECTIONS AND DEVICES

- A. CONNECTORS, COMPRESSION, COPPER, 600 VOLT: As manufactured by Burndy, Thomas & Betts, or Ideal Industries; of the appropriate hole sizes and spacing which are in accordance with NEMA standards; two (2) holes in the tongue for use on conductor sizes 250 kcmil or larger; not required for connections to the circuit breakers in the lighting and/or receptacle panels. All compression connectors shall be long-barrel type, no exceptions.
- B. 600 VOLT PLASTIC TAPE: Minnesota Mining & Manufacturing Company, No. 35.
- C. WIRENUTS: Silicone-based pre-filled spring wire connecting devices with plastic covering; UL listed for damp and wet locations. Wirenut shall meet requirements of UL 486D for Sealed Wire Connector Systems and shall be manufactured by Ideal Industries, Inc model 63, or as manufactured by ITT or Panduit. Wirenut shall be spring insulated, properly sized and resistant to vibration may be used for No.12 through No.10 solid gauge conductor for lighting and branch circuits only. Wirenut splices are only allowed in office areas for circuit lighting.
- D. MECHANICAL SET SCREW CONNECTOR: Blackburn HPS, ADR-ALCUL, GP or GT, Burndy or IlSCO; consisting of an aluminum body which has openings on opposite ends for insertion of the conductors. Conductors inserted into these holes shall each be clamped by two set screws. Connectors shall be suitable for use with copper conductors.
- E. INSULATED MECHANICAL SET SCREW CONNECTORS: Blackburn AMT connectors or equal, consisting of aluminum body which has openings for insertion of conductors to be clamped by set screws. Connectors shall be suitable for use with copper conductors.
- F. RUBBER TAPE: Scotch 2210.
- G. VINYL TAPE: Scotch 88.
- H. INSULATING RESIN: Scotch Resin 4 or Resin 4N.

- I. POWER DISTRIBUTION BLOCKS: Mersen, IlSCO or Allen-Bradley; rated for 600 VAC and termination of copper conductors. Individual poles shall be constructed of tin plated aluminum and mounted on an insulating base.

3.00 EXECUTION

3.01 PREPARATION

- A. Completely swab raceway system before installing conductors. Do not use cleaning agents and lubricants which have a deleterious effect on the conductors or their insulation.

3.02 INSTALLATION

A. GENERAL

1. Install raceway first as a complete system without conductors. Do not install pull wires and conductors until the raceway system is in place in accordance with the NEC and these specifications. Exception: Only flexible connections to motors shall be permitted to be installed after the installation of the remainder of the raceway system. The installation of these conductors shall be limited to exposure to damage for a maximum of one (1) week prior to installing flexible connection and making final terminations. Any conductors exposed to damage (i.e. not installed in raceway) longer than one (1) week shall be subject to rejection by the Owner and/or Engineer. If rejected, the cables shall be removed, discarded, replaced, reinstalled and re-termination at the Contractor's expense.
2. Installation of unapproved conductors shall be removed and replaced at the Contractor's expense. No exceptions.
3. Grouping conductors together into one conduit shall not be allowed where the plans indicate the conductors to be placed in separate conduits. Each home run shown on the plans shall be in its own conduit.
4. Neatly train wiring inside boxes, equipment and panelboards. Pull conductors into a raceway at the same time and use U.L. listed, wire pulling lubricant for pulling No. 4 AWG and larger wire.
5. Except for hand-pulled conductors into raceways, all wire and cable installation shall be installed with tension-monitoring equipment. Where conductors are found to have been installed without tension-monitoring, the conductors and cables shall be immediately removed from the raceways, permanently identified as rejected material, and removed from the jobsite. New conductors and cables shall be reinstalled, tagged and raceways resealed, all at the Contractor's expense.
6. Do not exceed cable manufacturer's recommendations for maximum pulling tensions and minimum bending radii. Where pulling compound is used, use only UL listed compound compatible with the cable outer jacket and with the raceway involved.
7. All wire and cable installed in cable trays shall be UL Listed as Type TC, for cable tray use.
8. Where single conductors and cables in manholes, hand holes, vaults, cable trays, and other indicated locations are not wrapped together by some other means such as arc and fireproofing tapes, bundle throughout their exposed length all conductors entering

from each conduit with nylon, self-locking, releasable, cable ties placed at intervals not exceeding 12 inches on center.

9. Properly support cables in accordance with the NEC and manufacturer's recommendations in all raceways. Provide strain relief as required.
10. Arrange wiring in cabinets and panels neatly, cut to proper length, remove surplus wire, bundle and secure in an acceptable manner. Identify all circuits entering motor control centers or other control cabinets in accordance with the conductor identification system specified herein and in specification section 26 05 53, IDENTIFICATION FOR ELECTRICAL SYSTEMS.
11. Cap conductors not terminated with the UL listed end caps.
12. Where conductors pass through holes or over edges in sheet metal, remove all burrs, chamfer all edges, and install bushings and protective strips of insulating material to protect the conductors.
13. For conductors that will be connected at a later time, provide at least 6 feet excess conductors in free standing panels and at least 2 feet excess in other assemblies. Provide additional excess conductors in any particular assembly where it is obvious that more conductor will be required to reach the termination point.

B. SPLICES

1. Power Conductors: All splices are subject to the Engineer's and Owner's approval. Obtain approval from Engineer before pulling conductors and installing any splices. Where allowed by the Engineer, splice in junction boxes or at outlets only for lighting and receptacle branch circuits. Splices for all other circuits shall be disallowed.
 - a. Splices with 120V, 208V or 240V installations, with wire sizes #10 and smaller, shall utilize wire nuts in enclosures only.
 - b. For splices of 277V or 480V circuits, the Contractor shall terminate conductors using wire nuts in a junction box for conductors up to #10. Conductors larger than #10 shall be spliced using power distribution blocks mounted to a backplane.
2. Condulet type fittings shall not contain splices.
3. Under no condition shall conductors of a different colors be spliced together.
4. If a splice is between final grade and 3' above the final grade, fill the spring connectors with an electrical insulating resin so that the resin encapsulates conductor and spring materials.
5. Conductor splices inside equipment enclosure panels (i.e. MCCs, VFDs, soft starters, etc.) shall be landed on the terminal strips or power distribution blocks mounted to a backplane.
6. For No. 8 and larger, connect conductors with a power distribution block or a mechanical, set screw type connector.
7. Wrap splices with a single half-lapped layer or rubber tape followed by successive layers of vinyl tape until a vinyl tape layer thickness of twice the original conductor insulation thickness is achieved.

C. TERMINATIONS

1. Furnish and install power distribution blocks as required at their load connection point with conductors of smaller size. Install power distribution blocks with the number of poles and sizes needed for connecting the phase, neutral, and ground conductors.
2. Tighten all screws and terminal bolts using torque type wrenches and/or drivers to tighten to the inch-pound requirements of the NEC and UL.
3. Soldered mechanical joints insulated with tape shall not be acceptable.
4. SINGLE CONDUCTORS: Sufficient wire length shall be left at outlets to make connections to equipment without straining. Light switches and receptacles shall be connected with pig-tails and twist-one spring type wire nuts.

D. TESTING

1. Contractor responsible for providing third party independent testing firm.
2. Perform tests and inspections and prepare test reports and submit to the Owner/Engineer prior to final inspection.
3. Tests and Inspections:
 - a. After installing conductors and cables and before electrical circuitry has been energized, test for compliance with requirements.
 - b. Perform each visual and mechanical inspection.
 - c. Test Reports: Prepare a written report to record the following:
 - 1). Test procedures used
 - 2). Test results that comply with requirements.
 - 3). Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.
 - d. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION

26 05 23 CONTROL-VOLTAGE ELECTRICAL POWER CABLES

1.00 GENERAL

1.01 WORK INCLUDED

- A. Furnish labor, materials, equipment and incidentals necessary to install 600 volt wires and cables. Electrical work shall be in accordance with Section 26 05 00, COMMON WORK RESULTS FOR ELECTRICAL.
- B. Work shall include building wire, cable, wiring connections and terminations, and modular wiring systems.

1.02 SUMMARY

- A. Section Includes:
 - 1. Low-voltage control cabling.
 - 2. Control-circuit conductors.
 - 3. Identification products.

1.03 DEFINITIONS

- A. EMI: Electromagnetic interference.
- B. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control and signaling power-limited circuits.
- C. Plenum: A space forming part of the air distribution system to which one or more air ducts are connected. An air duct is a passageway, other than a plenum, for transporting air to or from heating, ventilating, or air-conditioning equipment.
- D. UTP: Unshielded twisted pair.

1.04 SUBMITTALS

- A. Shop Drawings: For each type of product.
- B. Qualification Data: For qualified layout technician, installation supervisor, and field inspector.
- C. Source quality-control reports.
- D. Field quality-control reports.

1.05 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Member company of NETA or an NRTL.

2.00 PRODUCTS

2.01 SYSTEM DESCRIPTION

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.02 LOW-VOLTAGE CONTROL CABLE

- A. Paired Cable: NFPA 70, Type CMG.
 - 1. Individually and overall shielded one pair, twisted, No. 18 AWG, stranded tinned-copper conductors with 0.021" extruded PVC; 0.004" nylon insulation twisted into pairs, stranded into a core and enclosed by a non-hygroscopic core tape, 100% coverage, helically wound, aluminum foil shield, and drain wire. Pairs shall be black/red or black/white numbered. Cables shall be 600 volts in accordance with NEC-725 and IEEE 383 and shall be suitable for wet location.
 - 2. Shielded.
 - 3. Extruded PVC jacket minimum 0.050.
 - 4. Flame Resistance: Comply with UL 1685.

2.03 CONTROL-CIRCUIT CONDUCTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. General Cable; General Cable Corporation.
 - 2. Southwire Company.
 - 3. Alpha
 - 4. Okonite
 - 5. Belden
 - 6. Houston Wire and Cable
- B. General
 - 1. Wires and cables shall be soft-drawn, annealed copper with a conductivity of not less than that of 98% pure copper, UL83 and UL1063 listed, rated 600 volts and certified for continuous operation at maximum conductor temperature of 90 Celsius in dry locations and in wet locations.
 - 2. Control, signal and instrumentation circuits and as specifically indicated on the plans the minimum conductor permitted is #12.
- C. SINGLE CONDUCTOR CABLES: Tinned conductor with thermoplastic insulation rated at 600 volts and insulated with type XHHW-2 insulation. Wire shall be water tank tested and approved as machine tool wire, in accordance with National Machine Tool Builders Association.
- D. Class 1 Control Circuits: Stranded copper, Type XHHW-2, in raceway, complying with UL 44.
- E. Class 2 Control Circuits: Stranded copper, Type XHHW-2, in raceway, complying with UL 44.
- F. Class 3 Remote-Control and Signal Circuits: Stranded copper, Type XHHW-2, in raceway, complying with UL 44.

- G. Class 2 Control Circuits and Class 3 Remote-Control and Signal Circuits That Supply Critical Circuits: Circuit Integrity (CI) cable.

- 1. Smoke control signaling and control circuits.

2.04 SOURCE QUALITY CONTROL

- A. Testing Agency: Engage in a qualified testing agency to evaluate cables.
- B. Factory test UTP cables according to TIA-568-C.2.
- C. Factory test optical-fiber cables according to TIA-568-C.3.
- D. Cable will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

3.00 EXECUTION

3.01 EXAMINATION

- A. Test cables on receipt at Project site.
 - 1. Test optical-fiber cable to determine the continuity of the strand end to end. Use optical-fiber flashlight or optical loss test set.
 - 2. Test optical-fiber cable on reels. Use an optical time domain reflectometer to verify the cable length and locate cable defects, splices, and connector; include the loss value of each. Retain test data and include the record in maintenance data.
 - 3. Test each pair of UTP cable for open and short circuits.

3.02 INSTALLATION OF RACEWAYS AND BOXES

- A. Comply with requirements in Section 26 05 33 "Raceways and Boxes for Electrical Systems" for raceway selection and installation requirements for boxes, conduits, and wireways as supplemented or modified in this Section.
 - 1. Outlet boxes shall be no smaller than 2 inches wide, 3 inches high, and 2-1/2 inches deep.
 - 2. Outlet boxes for optical-fiber cables shall be no smaller than 4 inches square by 2-1/8 inches deep with extension ring sized to bring edge of ring to within 1/8 inch of the finished wall surface.
 - 3. Flexible metal conduit shall not be used.
- B. Comply with TIA-569-B for pull-box sizing and length of conduit and number of bends between pull points.
- C. Install manufactured conduit sweeps and long-radius elbows if possible.
- D. Raceway Installation in Equipment Rooms:
 - 1. Position conduit ends adjacent to a corner on backboard if a single piece of plywood is installed, or in the corner of the room if multiple sheets of plywood are installed around perimeter walls of the room.

2. Install cable trays to route cables if conduits cannot be located in these positions.
 3. Secure conduits to backboard if entering the room from overhead.
 4. Extend conduits 3 inches above finished floor.
 5. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.
- E. Backboards: Install backboards with 96-inch dimension vertical. Butt adjacent sheets tightly and form smooth gap-free corners and joints.

3.03 INSTALLATION OF CONDUCTORS AND CABLES

A. Comply with NECA 1 and NFPA 70.

B. General Requirements for Cabling:

1. Comply with TIA-568-C Series of standards.
2. Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems" and Ch. 6, "Optical Fiber Structured Cabling Systems."
3. Terminate all conductors and optical fibers; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, and cross-connect and patch panels.
4. Cables may not be spliced.
5. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
6. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems" and Ch. 6, "Optical Fiber Structured Cabling Systems." Install lacing bars and distribution spools.
7. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
8. Control and Instrumentation Conductors: No splicing of control and instrumentation conductors shall be permitted between terminal points except as specifically indicated on the plans unless approved by the engineer.
9. Cold-Weather Installation: Bring cable to room temperature before de-reeling. Do not use heat lamps for heating.
10. Pulling Cable: Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems" and Ch. 6, "Optical Fiber Structured Cabling Systems." Monitor cable pull tensions.
11. Support: Do not allow cables to lay on removable ceiling tiles.
12. Secure: Fasten securely in place with hardware specifically designed and installed so as to not damage cables.

C. UTP Cable Installation:

1. Comply with TIA-568-C.2.

2. Do not untwist UTP cables more than 1/2 inch at the point of termination to maintain cable geometry.
- D. Installation of Control-Circuit Conductors:
1. Install wiring in raceways. Comply with requirements specified in Section 26 05 33 "Raceways and Boxes for Electrical Systems."
- E. Optical-Fiber Cable Installation:
1. Comply with TIA-568-C.3.
 2. Terminate cable on connecting hardware that is rack or cabinet mounted.
- F. Open-Cable Installation:
1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
 2. Suspend copper cable not in a wireway or pathway a minimum of 8 inches above ceilings by cable supports not more than 30 inches apart.
 3. Cable shall not be run through or on structural members or in contact with pipes, ducts, or other potentially damaging items. Do not run cables between structural members and corrugated panels.
- G. Separation from EMI Sources:
1. Comply with BICSI TDMM and TIA-569-B recommendations for separating unshielded copper voice and data communications cable from potential EMI sources including electrical power lines and equipment.
 2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
 - a. Electrical Equipment or Circuit Rating Less Than 2 kVA: A minimum of 5 inches.
 - b. Electrical Equipment or Circuit Rating between 2 and 5 kVA: A minimum of 12 inches.
 - c. Electrical Equipment or Circuit Rating More Than 5 kVA: A minimum of 24 inches.
 3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
 - a. Electrical Equipment or Circuit Rating Less Than 2 kVA: A minimum of 2-1/2 inches.
 - b. Electrical Equipment or Circuit Rating between 2 and 5 kVA: A minimum of 6 inches.
 - c. Electrical Equipment or Circuit Rating More Than 5 kVA: A minimum of 12 inches.
 4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
 - a. Electrical Equipment or Circuit Rating Less Than 2 kVA: No requirement.
 - b. Electrical Equipment or Circuit Rating between 2 and 5 kVA: A minimum of 3 inches.
 - c. Electrical Equipment or Circuit Rating More Than 5 kVA: A minimum of 6 inches.

5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or 5 HP and Larger: A minimum of 48 inches.
 6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches.
- H. PAIRED SHIELDED AND TRIAD SHIELDED CABLE: Ground paired shielded and triad shielded cables at the instrument panel or instrument end only and isolate from other grounds. The shield shall be continuous from termination to termination. The paired shielded and triad shielded cable shall not be placed in the same conduit or cable tray with power cables and digital control cables. Each termination of paired shielded or triad shielded cable shall be coated with silicone jelly after termination. The shield of pair shielded cable and triad shielded cable shall only be broken when the conductors are terminated on terminal strips. Each conductor and shield shall be landed on its own terminal. Sharing of shield shall not be allowed.

3.04 REMOVAL OF CONDUCTORS AND CABLES

- A. Remove abandoned conductors and cables. Abandoned conductors and cables are those installed that are not terminated at equipment and are not identified for future use with a tag.

3.05 CONTROL-CIRCUIT CONDUCTORS

- A. Minimum Conductor Sizes:
1. Class 1 remote-control and signal circuits; No 14 AWG.
 2. Class 2 low-energy, remote-control, and signal circuits; No. 16 AWG.
 3. Class 3 low-energy, remote-control, alarm, and signal circuits; No 12 AWG.
- B. Control conductors #14 and smaller (where allowed) shall be terminated on a screw termination with a crimp on type spade connector. The connector wire sleeve shall be rated for the conductor size and only applied on the wire end. Doubling the conductor in the sleeve for a tighter fit shall not be allowed. Provide Panduit PanTerm or approved equal.
- C. Splicing control conductors with wire nuts, but splice connectors, or any other means other than terminal blocks is not acceptable.

3.06 GROUNDING

- A. For data communication wiring, comply with ANSI-J-STD-607-A and with BICSI TDM, "Bonding and Grounding (Earthing)" Chapter.
- B. For low-voltage control wiring and cabling, comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

3.07 IDENTIFICATION

- A. Comply with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."

- B. Identify data and communications system components, wiring, and cabling according to TIA-606-A; label printers shall use label stocks, laminating adhesives, and inks complying with UL 969.

3.08 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- C. Perform the following tests and inspections:
 - 1. Visually inspect UTP and optical-fiber cable jacket materials for UL or third-party certification markings. Inspect cabling terminations to confirm color-coding for pin assignments, and inspect cabling connections to confirm compliance with TIA-568-C.1.
 - 2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
 - 3. Test UTP cabling for direct-current loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not after cross-connection.
 - a. Test instruments shall meet or exceed applicable requirements in TIA-568-C.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
 - 4. Optical-Fiber Cable Tests:
 - a. Test instruments shall meet or exceed applicable requirements in TIA-568-C.0. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
 - b. Link End-to-End Attenuation Tests:
 - 1). Multimode Link Measurements: Test at 850 or 1300 nm in one direction according to TIA/EIA-526-14-A, Method B, One Reference Jumper.
 - 2). Attenuation test results for links shall be less than that calculated according to equation in TIA-568-C.0.
- D. Document data for each measurement. Print data for submittals in a summary report that is formatted using Table 10.1 in BICSI TDMM as a guide, or transfer the data from the instrument to the computer, save as text files, print, and submit.
- E. End-to-end cabling will be considered defective if it does not pass tests and inspections.
- F. Prepare test and inspection reports.

END OF SECTION

26 05 26 GROUNDING & BONDING FOR ELECTRICAL SYSTEMS

1.00 GENERAL

1.01 WORK INCLUDED

- A. Furnish labor, materials, equipment and incidentals necessary to install a complete grounding system in strict accordance with Article 250 of the National Electrical Code (NEC) as shown on the drawings or as specified herein. Electrical work shall be in accordance with Section 26 05 00, Common Work Results for Electrical.
- B. Every structure shall have a ground ring around the structure.
- C. Grounding shall be coordinated with Lightning Protection Systems.

1.02 SUBMITTALS

Submittal shall be in accordance with Section 01 33 00, Document Management and shall include:

- A. Shop Drawings
 - 1. Grounding materials, equipment and processes.
- B. Field quality-control test reports.

1.03 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with UL 467 for grounding and bonding materials and equipment.

1.04 JOB CONDITIONS

- A. Measure the ground grid resistance with the earth test megger and install additional ground rods and conductors as required until the resistance to the ground conforms to National Electrical Code requirements. Ground resistance measurement shall not exceed 5 ohms. Add ground rods as required to bring resistance to 5 ohms and connect to grounding system.

2.00 PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Burndy; Part of Hubbell Electrical Systems.
 - 2. ERICO International Corporation.
 - 3. Harger Lightning & Grounding.
 - 4. ILSCO.

5. O-Z/Gedney; a brand of Emerson Industrial Automation.
6. Thomas & Betts Corporation, A Member of the ABB Group.

2.02 CONDUCTORS

- A. Insulated Conductors: tinned-copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.
- B. Tin-plated Bare Copper Conductors:
 1. Solid Conductors: ASTM B 3.
 2. Stranded Conductors: ASTM B 8.
 3. Tinned Conductors: ASTM B 33.
 4. Bonding Conductor: No. 4 AWG, stranded conductor.
 5. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
 6. Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

2.03 CONNECTORS

- A. Listed and labeled by a Nationally Recognized Testing Laboratory (NRTL) acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.
- B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, bolted pressure-type, with at least two bolts.
- C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.
- D. Bus-Bar Connectors: Mechanical type, cast silicon bronze, solderless compression type wire terminals, and long-barrel, two-bolt connection to ground bus bar.

2.04 GROUNDING ELECTRODES

- A. Ground Rods: copper clad; 3/4 inch by 10 feet.
- B. Ground Plate Electrodes: 1/4" thick, 2'-0" wide x 2'-0" long serrated copper plate with #4/0 tinned copper conductor terminated ten (10) foot welded pigtail connection, ALT Fabrication Item #3280-40 or equal.

2.05 MISCELLANEOUS

- A. CONDUIT GROUND FITTINGS: Fittings for bonding ground cable to the conduit shall be FCI Burndy Corp., type NE or Thomas & Betts No. 3951 series.
- B. GROUND ROD BOXES: Precast Box with cast iron lid. Lid shall read "ground rod". H-10 rated boxes shall be Brooks Precast Model "3-RT" or approved equal. Ground rod boxes located in driveway areas shall have an AASHO HS-20 rating by ALT Fabrication Item #3114 or approved equal.

- C. EXOTHERMIC WELDING PROCESS: CADWELD MATERIALS – as manufactured by ERICO products or approved equal.

2.06 PROCESSES

- A. All grounding system connections to building steel and ground rods shall be exothermically welded including all cable connections, and cable steel terminations. The use of mechanical type connections is not acceptable.
- B. Any concealed connection (buried, encased in concrete or otherwise sealed) shall be done only with exothermic welds.
- C. All materials involved must be from the same sources to insure compatibility. Connections made from this process shall meet the requirements of IEEE Standards 80 and 837 and as listed in MIL 419 and other standards, National Electrical Code, etc.

2.07 GROUNDING SYSTEM

- A. Provide a grounding system that includes all connections and the testing of ground rods, ground cables, ground buses, conduits, fittings, anchor supports, thermite process materials and equipment and other materials required for a complete installation. Grounding system shall be installed and sized in accordance with the National Electrical Code.

3.00 EXECUTION

3.01 INSTALLATION

- A. Conductor Terminations and Connections:
 - 1. Pipe and Equipment Grounding Conductor Terminations: Bolted/clamp type connectors.
 - 2. Underground Connections: Exothermically welded connectors, except at test wells and as otherwise indicated.
 - 3. Connections to Ground Rods at Test Wells: Exothermically welded connectors.
 - 4. Connections to Structural Steel: Exothermically welded connectors.
- B. Ground electrical work in accordance with NEC Article 250 and local codes.
- C. Install ground cables in conduits above grade or directly buried in earth to a depth of not less than 12" below grade. Installation to provide sufficient mechanical protection so as not to break ground cables or connections.
- D. Install ground cables continuously between connections. Splices shall not be permitted, except where indicated on the plans. Where ground cables pass through floor slabs, buildings, etc., and when not in metallic enclosures, provide a sleeve of approved, non-metallic materials.
- E. Install a green-colored, equipment grounding conductor in raceways. Size conductors in accordance with NEC Article 250.
- F. Where ground wire is directly buried in earth or concrete, use standard bare tinned copper cable, in all other cases install a green-colored insulation, equipment grounding conductor in

accordance with Section 26 05 19, Low Voltage Conductors & Cables. Size conductors in accordance with NEC Article 250. Provide grounding conductors as required per the NEC.

- G. Metal conduits stubbed up into switchgear, motor control center or other electrical equipment shall be terminated with insulated grounding bushings and connected to the equipment ground bus. Size the grounding wire in accordance with applicable sections of the National Electrical Code.
- H. Provide exothermic weld connection for extension to existing stub-up ground conductors.
- I. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance, except where routed through short lengths of conduit.
 - 1. Provide grounding and bonding jumpers as required per the NEC.
 - 2. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
 - 3. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install so vibration is not transmitted to rigidly mounted equipment.
 - 4. Use exothermic-welded connectors for outdoor locations, but if a disconnect-type connection is required, use a bolted clamp.
- J. Grounding and Bonding for Piping:
 - 1. Metal Water Service Pipe: Install insulated tinned copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes, using a bolted clamp connector or by bolting a lug-type connector to a pipe flange, using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
 - 2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
 - 3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.
- K. Liquid tight flexible metal conduit in sizes 1-1'2" or larger shall have bonding jumpers. Bonding jumpers shall be external, run in parallel (not spiraled) and fastened with plastic tie wraps. Contractor shall provide bonding jumpers sized in accordance with the National Electrical Code.
- L. All equipment enclosures, equipment racks, motor and transformer frames, conduit systems, cable armor, exposed structural steel and all other equipment and materials shall be grounded using a grounding conductor. Ground conductor shall be sized as required by the NEC.
- M. Ground transformer neutrals to the nearest available grounding electrode with a conductor sized in accordance with NEC Article 250.
- N. Where exothermic bonding is used, molds shall be of the appropriate size for the wire and rod used. All bonds shall remain exposed for inspection of the Owner's Representative.

- O. Ground rod shall be installed such that the top of the ground rod is 5" below grade and enclosed by a ground rod box.
- P. Conduit terminations shall be grounded.
- Q. Enclosures and doors shall be grounded.
- R. Provide ground ring around every structure, whether shown on the plans or not.
 - 1. Spacing between ground rods shall be no more than 20'.
 - 2. Each corner of the structure shall have a test well. Where structures do not have corners, there shall be a minimum of 4 ground test wells spaced evenly around the structure.

3.02 INSPECTION

- A. Inspect the grounding and bonding system conductors and connections for tightness and proper installation.
- B. Use Biddle Direct Reading Earth Resistance Tester or equivalent to measure resistance to ground of the system. Perform testing in accordance with the test instrument manufacturer's recommendation using the fall of potential method.
- C. All test equipment shall be provided under this section and approved by the Engineer.
- D. Resistance to ground testing shall be performed during dry season. Submit test results in the form of a graph showing the number of points measured (12 minimum) and the numerical resistance to ground.
- E. Testing shall be performed before energizing the distribution system.
- F. A separate test shall be conducted for each building or system.
- G. Notify the Engineer immediately if the resistance to ground for any building or system is greater than five ohms. Ground resistance measurement shall not exceed 5 ohms. Provide additional ground rods and conductors as required to bring the resistance top five ohms.

END OF SECTION

26 05 29 HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

1.00 GENERAL

1.01 WORK INCLUDED

- A. This Section includes the following:
 - 1. Hangers and supports for electrical equipment and systems.
 - 2. Construction requirements for concrete bases.

1.02 DEFINITIONS

- A. IMC: Intermediate metal conduit.
- B. RMC: Rigid metal conduit.

1.03 PERFORMANCE REQUIREMENTS

- A. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.
- B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
- C. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.

1.04 SUBMITTALS

- A. Submittals shall be in accordance with Section 01 33 00 "Document Management" and shall include:
 - 1. Product Data: For each type of product.
 - a. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for the following:
 - 1). Hangers.
 - 2). Steel slotted support systems.
 - 3). Nonmetallic support systems.
 - 4). Trapeze hangers.
 - 5). Clamps.
 - 6). Turnbuckles.
 - 7). Sockets.
 - 8). Eye nuts.
 - 9). Saddles.
 - 10). Brackets.

- b. Include rated capacities and furnished specialties and accessories.

1.05 QUALITY ASSURANCE

- A. Comply with NFPA 70.

1.06 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

2.00 PRODUCTS

2.01 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. All supporting hardware shall be 304 stainless steel.
- B. 304 Stainless Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Allied Tube & Conduit.
 - b. Cooper B-Line, Inc.; a division of Cooper Industries.
 - c. Fabco Plastics Wholesale Limited.
 - d. Seasafe, Inc.
 - e. No others approved.
 - 2. Fittings and Accessories: Products of channel and angle manufacturer and designed for use with those items.
 - 3. Fitting and Accessory Materials: Same as channels and angles, except metal items shall be 304 stainless steel.
 - 4. Rated Strength: Selected to suit applicable load criteria.
- C. Raceway and Cable Supports: As described in NECA 1 and NECA 101.
- D. Conduit and Cable Support Devices: 304 Stainless Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- E. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.
- F. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, 304 stainless steel plates, shapes, and bars.
- G. Personal Protection:
 - 1. Yellow Plastic End Cap.

2. Yellow Rubber End Cap.
- H. Coordinate paragraph and subparagraphs below with installation requirements in Part 3.
- I. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
 1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
 2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Hilti Inc.
 - b. ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
 - c. MKT Fastening, LLC.
 - d. Simpson Strong-Tie Co., Inc.; Masterset Fastening Systems Unit.
 - e. No others approved.
 3. Mechanical-Expansion Anchors: Insert-wedge-type, stainless steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
 4. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Cooper B-Line, Inc.; a division of Cooper Industries.
 - b. Empire Tool and Manufacturing Co., Inc.
 - c. Hilti Inc.
 - d. ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
 - e. MKT Fastening, LLC.
 - f. No others approved.
 5. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
 6. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
 7. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
 8. Toggle Bolts: Springhead type, 304 stainless steel.
 9. Hanger Rods: Threaded, 304 stainless steel.

2.02 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

- A. Description: Bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

3.00 EXECUTION

3.01 APPLICATION

- A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.
- B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for IMC, and RMC as required by NFPA 70. Minimum rod size shall be 1/4 inch in diameter.
- C. Horizontal channel strut: Conduit clamps shall not come within 3" of the end of the channel strut.
- D. Vertical channel strut: Conduit clamps shall not come within 6" of the bottom of the channel strut and 2" of the top of the channel strut.
- E. Multiple Raceways or Cables: Install trapeze-type supports fabricated with stainless steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
 - 1. Secure raceways and cables to these supports with two-bolt conduit clamps and single bolt conduit clamps using spring friction action for retention in support channel.
- F. Spring- stainless steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

3.02 SUPPORT INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.
- B. Raceway Support Methods: In addition to methods described in NECA 1, RMC may be supported by openings through structure members, as permitted in NFPA 70.
- C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.
- D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
 - 1. To Wood: Fasten with lag screws or through bolts.
 - 2. To New Concrete: Bolt to concrete inserts.
 - 3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
 - 4. To Existing Concrete: Expansion anchor fasteners.
 - 5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches thick.
 - 6. To Steel: Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69.

- 7. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate.
- E. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.03 FINISH

- A. Debur all cuts to strut.
- B. Provide plastic end caps on all strut end pieces. Then provide rubber end cap over the top of the plastic end cap.

3.04 INSTALLATION OF FABRICATED METAL SUPPORTS

- A. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

END OF SECTION

26 05 33 RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

1.00 GENERAL

1.01 WORK INCLUDED

- A. Furnish labor, materials, equipment and incidentals necessary to install a complete conduit system for each type of electrical system. Electrical work shall be in accordance with Div. 26 ELECTRICAL specifications.
- B. Furnish labor, materials, equipment and incidentals necessary to install concrete electrical manholes and pull boxes, as specified and indicated on the plans. Manhole sizes shown on the plans are the minimum size allowed. CONTRACTOR shall be responsible for sizing all manholes and pull boxes in accordance with the National Electrical Code, Article 370 and relevant sections of the NEC. CONTRACTOR shall be responsible for setting elevations at manhole and cable entry locations to meet the intent of the specifications and plans.
- C. The CONTRACTOR shall be responsible for sizing all pull boxes and junction boxes per the National Electrical Code (NEC) Article 314 and all other relevant sections of the NEC. Electrical work shall be in accordance with Section 26 05 00, COMMON WORK RESULTS FOR ELECTRICAL.

1.02 SUMMARY

- A. Section Includes:
 - 1. Metal conduits, tubing, and fittings.
 - 2. Nonmetal conduits, tubing, and fittings.
 - 3. Metal wireways and auxiliary gutters.
 - 4. Nonmetal wireways and auxiliary gutters.
 - 5. Surface raceways.
 - 6. Boxes, enclosures, and cabinets.
 - 7. Handholes and boxes for exterior underground cabling.

1.03 DEFINITIONS

- A. ARC: Aluminum rigid conduit.
- B. GRC: Galvanized rigid steel conduit.
- C. FMC: Flexible metal conduit
- D. LFMC: Liquidtight flexible metallic conduit
- E. HDPE: High-density polyethylene conduit
- F. RNC: Rigid nonmetallic conduit

1.04 SUBMITTALS

- A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.
- B. CONTRACTOR shall provide detailed conduit layout showing number, size, and location of conduits entering the manholes. Cables routed in conduits shall be clearly identified. Details shall also show elevation of conduits entering manholes. Manhole details shall be submitted to the ENGINEER for approval prior to the duct bank/manhole system being installed.
- C. Manholes, Pull and Junction Boxes Sizing Calculations: Detailed calculations shall be submitted to the ENGINEER with the manholes, pull and junction boxes' initial submittal. Submittals submitted without sizing calculations shall not be accepted.

2.00 PRODUCTS

2.01 METAL CONDUITS, TUBING, AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. AFC Cable Systems; a part of Atkore International.
 - 2. Allied Tube & Conduit; a part of Atkore International.
 - 3. Anamet Electrical, Inc.
 - 4. Electri-Flex Company.
 - 5. FSR Inc.
 - 6. O-Z/Gedney; a brand of Emerson Industrial Automation.
 - 7. Picoma Industries, Inc.
 - 8. Republic Conduit.
 - 9. Robroy Industries.
 - 10. Calbond.
 - 11. Southwire Company.
 - 12. Thomas & Betts Corporation, A Member of the ABB Group.
 - 13. Western Tube and Conduit Corporation.
 - 14. Wheatland Tube Company.
- B. Listing and Labeling: Metal conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. GRC: Comply with ANSI C80.1 and UL 6.
- D. ARC: Comply with ANSI C80.5 and UL 6A.
- E. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit.

1. Comply with NEMA RN 1, UL 6, ANSI C80.1
 2. Coating Thickness: 0.040 inch, minimum.
- F. PVC-Coated Aluminum Conduit: PVC-coated.
1. Comply with UL 6A.
 2. Coating Thickness: 0.040 inch, minimum.
- G. FMC: Comply with UL 1; aluminum.
- H. LFMC: Flexible aluminum conduit with PVC jacket.
- I. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.
1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886 and NFPA 70.
 2. Fittings for Rigid Aluminum:
 - a. Material: Aluminum.
 - 1). Type: Form 7.
 - b. Class I and II Hazardous locations:
 - 1). Material: Copper-free aluminum.
 - 2). Type: Series OE, LBH and LBY
 - 3). Covers: Copper-free aluminum
 3. Fittings for PVC Coated Rigid Aluminum:
 - a. Material: PVC Coated Cast Aluminum
 - b. Type: Form Form 7
 - c. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch, with overlapping sleeves protecting threaded joints.
- J. Expansion Fittings: PVC, aluminum, or steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper, Crouse Hinds XJG 4" or equal with bonding jumper for aluminum or steel. Where expansion/deflection fitting is specified on the drawings, provide Crouse Hinds XJGD or equal.
- K. Insulated Grounding Bushings: Threaded bushings, O-Z Type ABLG with lay-in means of grounding conduit.
- L. Fittings for LFMC
1. Fittings for aluminum LFMC shall be aluminum with reinforced sealing ring, external grounding lugs, and insulated throat. Fittings shall be Emerson STB-L or equal.
 2. Fittings for steel LFMC shall be steel with reinforced sealing ring, external grounding lug, and insulated throat. Fittings shall be Emerson STB-L or equal.
- M. Fittings for LFNC
1. Fittings for LFNC shall be PVC with reinforced sealing ring and insulated throat.

- N. Joint Compound for IMC, GRC, or ARC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.
 - 1. Aluminum conduit: Penetrox A-13 or approved equal.
 - a. UL Listed
 - b. Compatible with insulating materials such as rubber, or polyethylene.
 - c. Rated for all voltages
 - 2. Steel conduit: Kopr Sheild CP8-TB or approved equal.
 - a. UL Listed
 - b. Rated up to 8kV applications
- O. Sealing Compound:
 - 1. Hazardous locations: Chico "A" or Chico SpeedSeal, Hydra-Seal S-60 or approved equal.
- P. Lubricants:
 - 1. Hazardous Class I, Div. II locations
 - a. Metal-to-metal joint: STL thread lubricant.
 - 1). Applicable to dissimilar metals
 - 2). Maintain grounding continuity
 - b. Lighting Fixture Threaded joint: HTL high temperature lubricant
 - 1). Applicable to dissimilar metals
 - 2). Maintain grounding continuity

2.02 NONMETALLIC CONDUITS, TUBING, AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. AFC Cable Systems; a part of Atkore International.
 - 2. Anamet Electrical, Inc.
 - 3. Arnco Corporation.
 - 4. CANTEX INC.
 - 5. CertainTeed Corporation.
 - 6. Condux International, Inc.
 - 7. Electri-Flex Company.
 - 8. Kraloy.
 - 9. Lamson & Sessions.
 - 10. Niedax Inc.
 - 11. RACO; Hubbell.

12. Thomas & Betts Corporation, A Member of the ABB Group.

- B. Listing and Labeling: Nonmetallic conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. ENT: Comply with NEMA TC 13 and UL 1653.
- D. RNC: Type EPC-40-PVC, Type EPC-80-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.
- E. LFNC: Comply with UL 1660.
- F. RTRC: Comply with UL 1684A and NEMA TC 14.
- G. Fittings for ENT and RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.
- H. Fittings for LFNC: Comply with UL 514B.

2.03 METAL WIREWAYS AND AUXILIARY GUTTERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. B-line, an Eaton business.
 - 2. Hoffman; a brand of Pentair Equipment Protection.
 - 3. MonoSystems, Inc.
 - 4. Square D.
- B. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 1, Type 3R, Type 4X 304 stainless steel unless otherwise indicated, and sized according to NFPA 70.
 - 1. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
- D. Wireway Covers: Hinged type with luggage type clasps unless otherwise indicated.
- E. Finish: Manufacturer's standard enamel finish.
- F. Wireways shall come with a threaded grounding post welded to the enclosure used for grounding.

2.04 SURFACE RACEWAYS

- A. Listing and Labeling: Surface raceways and tele-power poles shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Surface Metal Raceways: Complying with UL 5. Manufacturer's standard enamel finish in color selected by Engineer.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Hubbell Incorporated; Wiring Device-Kellems.
 - b. MonoSystems, Inc.
 - c. Panduit Corp.
 - d. Wiremold / Legrand.
- C. Tele-Power Poles:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. MonoSystems, Inc.
 - b. Panduit Corp.
 - c. Wiremold / Legrand.
 - 2. Material: Aluminum with clear anodized finish.
 - 3. Fittings and Accessories: Dividers, end caps, covers, cutouts, wiring harnesses, devices, mounting materials, and other fittings shall match and mate with tele-power pole as required for complete system.

2.05 BOXES, ENCLOSURES, AND CABINETS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Adalet.
 - 2. Crouse-Hinds, an Eaton business.
 - 3. EGS/Appleton Electric.
 - 4. Erickson Electrical Equipment Company.
 - 5. FSR Inc.
 - 6. Hoffman; a brand of Pentair Equipment Protection.
 - 7. Hubbell Incorporated.
 - 8. Kraloy.
 - 9. Milbank Manufacturing Co.
 - 10. MonoSystems, Inc.

11. Oldcastle Enclosure Solutions.
 12. O-Z/Gedney; a brand of Emerson Industrial Automation.
 13. RACO; Hubbell.
 14. Robroy Industries.
 15. Spring City Electrical Manufacturing Company.
 16. Stahlin Non-Metallic Enclosures.
 17. Thomas & Betts Corporation, A Member of the ABB Group.
 18. Wiremold / Legrand.
- B. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.
- C. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.
- D. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, aluminum, Type FD, with gasketed cover.
1. Outlet boxes for Rigid Aluminum:
 - a. Material: Aluminum.
 - 1). Type: Form 7.
 - b. Class I and II Hazardous locations:
 - 1). Material: Copper-free aluminum.
 - 2). Type: Series GUA
 - 3). Covers: Copper-free aluminum
 2. Outlet boxes for PVC Coated Rigid Aluminum:
 - a. Material: PVC Coated Cast Aluminum
 - b. Type: Form 7
 - c. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch, with overlapping sleeves protecting threaded joints.
- E. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.
- F. Metal Floor Boxes:
1. Material: Cast metal.
 2. Type: Fully adjustable.
 3. Shape: Rectangular.
 4. Listing and Labeling: Metal floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- G. Luminaire Outlet Boxes: Nonadjustable, designed for attachment of luminaire weighing 50 lb. Outlet boxes designed for attachment of luminaires weighing more than 50 lb shall be listed and marked for the maximum allowable weight.

- H. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- I. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, cast aluminum with gasketed cover.
- J. Box extensions used to accommodate new building finishes shall be of same material as recessed box.
- K. Gangable boxes are allowed.
- L. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1, Type 3R, Type 4X, and Type 12 with continuous-hinge cover with flush latch unless otherwise indicated.
 - 1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel, 304 stainless steel as indicated.
 - 2. Nonmetallic Enclosures: Fiberglass.
 - 3. Interior Backplane Panels: Steel; all sides finished with manufacturer's standard enamel.
 - 4. Enclosures shall include a grounding kit.

2.06 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

- A. General Requirements for Handholes and Boxes:
 - 1. Boxes and handholes for use in underground systems shall be designed and identified as defined in NFPA 70, for intended location and application.
 - 2. Boxes installed in wet areas shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 3. Handhole details are indicated on the contract documents.
- B. Manholes and Concrete Pullboxes
 - 1. ACCEPTABLE MANUFACTURERS; PRECAST: Precast concrete products shall comply with the specifications and shall be produced by the following Manufacturers:
 - a. Brooks Products
 - b. American Industrial Precast Products
 - c. Dalworth Quickset Co.
 - d. Old Castle
 - e. No Equal
 - 2. ACCEPTABLE MANUFACTURERS; CASTINGS: Metal castings shall comply with the specifications and shall be produced by the following Manufacturers:
 - a. McKinley Iron Works, Fort Worth, TX
 - b. Neenah Foundry, Neenah, WI
 - c. No equal.
 - 3. DESIGN CRITERIA: Concrete for precast concrete shall obtain a compressive strength of 4000 psi minimum at 28 days, and shall be an air-entrained mix of the Manufacturer's standard mix design.

4. STANDARDS

- a. The applicable provisions of the following standards shall apply as if written here in their entirety:

AASHO H-20	"Standard Specifications for Highway Bridges"
ANSI/ASTM A-15	"Zinc Coating (Hot Dipped) on Iron and Steel Hardware"
ANSI/ASTM A-569	"Steel, Sheet and Strip, Carbon (0.15% Maximum), Hot Rolled, Commercial Quality."
ASTM A-48	"Gray Iron Castings"
ASTM A-123	"Zinc (Hot Galvanized) Coatings on Products fabricated from Rolled, Pressed, and Forged Steel Shapes, Plates, Bars, and Strips."

5. Materials

- a. MANHOLE FRAMES AND COVERS: Class 30B gray cast iron conforming to ASTM A-48; machine finished with flat bearing surfaces.
- b. SUMP COVERS: Class 30B gray cast iron conforming to ASTM A-48.
- c. PULLING IRONS: 316 Stainless Steel bar with 7/8" diameter forming a triangle of 9" per side when set; galvanized according to ANSI/ASTM A-153 for irregularly shaped articles.
- d. CABLE RACK INSERTS: 316 Stainless Steel channel inserts with a minimum load rating of 800 pounds; length to match cable rack channel.
- e. CABLE RACK CHANNEL: 4" x 1-1/2" x 3/16" 316 stainless steel channel wall bracket, 48" long, with cable rack arm mounting slots on 8" centers.
- f. CABLE RACKS: 2-1/2" x 14" 316 stainless steel channel with high glazed, wet-process porcelain insulators conforming to ANSI/ASTM A-569.
- g. GROUND ROD: 3/4" x 10' copper clad steel, installed in the floor of the manhole, and all metallic cable racks, irons, etc. grounded (to the ground rod). Ground rod may be field installed, but floor penetration shall be sealed against the entrance of water under positive head.
- h. JOINT SEALANT: Flexible plastic gasket of flexible butyl resin sealant.
- i. DAMPPROOFING: Sonneborn, Div. of ChemRex, Inc. or approved equal.
- 1). BITUMINOUS DAMPPROOFING
- a). Cold-Applied, Emulsified-Asphalt Dampproofing:
- b). Brush and Spray Coats: ASTM D 1227, Type III, Class 1.
- 2). MISCELLANEOUS MATERIALS
- a). Emulsified-Asphalt Primer: ASTM D 1227, Type III, Class 1, except diluted with water as recommended by manufacturer.

6. Mixes

- a. Concrete and reinforcing shall be in accordance with Section 03 30 00, "Cast-In-Place Concrete".

2.07 SOURCE QUALITY CONTROL FOR UNDERGROUND ENCLOSURES

- A. Handhole and Pull-Box Prototype Test: Test prototypes of handholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.
 1. Strength tests of complete boxes and covers shall be by either an independent testing agency or manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
 2. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012 and traceable to NIST standards.

3.00 EXECUTION

3.01 CONDUIT INSTALLATION SCHEDULE

- A. Conduit types shall be installed in accordance with the following schedule and as indicated throughout this specification:
 1. ABOVE GRADE NON CONCEALED CONDUIT: ARC unless noted otherwise.
 2. PVC COATED RIGID ALUMINUM CONDUIT: Shall be used for conduit stub-ups through concrete and concrete wall penetrations.
 3. RIGID ALUMINUM CONDUIT: May be used in all locations. PVC coated rigid aluminum conduit shall be used in corrosive environments or where in contact with concrete.
 4. Concealed Conduit (through concrete or masonry), Aboveground: PVC coated rigid aluminum conduit.
 5. LIQUID TIGHT FLEXIBLE METALLIC CONDUIT: Shall only be used to equipment in non-hazardous locations not subject to physical damage or excessive temperatures, requiring vibration isolation unless otherwise indicated, 6'-0" maximum length. The bending radius shall be in accordance with Chapter 9, Table 2 of the NEC and shall not deform or alter the flex jacket.
 6. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
 7. Boxes and Enclosures, Aboveground for Class I, Div. 2 hazardous locations: NEMA 250 cast aluminum Type 7.
- B. Minimum Raceway Size:
 1. Exposed 1/2" for light fixture whips, 3/4" trade size.
 2. Underground: 2" in duct banks. 1" independent conduits for power to light poles.
- C. Raceway Fittings: Compatible with raceways and suitable for use and location.

1. Rigid Aluminum Conduit: Use threaded rigid aluminum conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
 2. PVC Externally Coated, Rigid Aluminum Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.
 3. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.
- D. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.
- E. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F.
- F. All metallic conduit terminations shall include an insulated throat. If the insulated throat is damaged after pulling wire, the insulated throat insert shall be replaced with Polypropylene Lock-A-Liner Rigid IMC Insulating Bushing for conduit up to $\frac{3}{4}$ " and plastic split conduit bushings for all other conduit sizes. Split conduit bushing shall be secured with zip tie after installation.

3.02 CONDUIT INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum conduits. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.
- B. Use the conduit route where shown on the plans. Route conduits that do not have a specified route in the most direct path between the two points, i.e. home runs shown with an arrow symbol. Route conduits parallel to building lines. Concealed conduits on the plans shall be below grade, within walls, or above ceilings.
- C. Route conduit through roof openings for piping and ductwork where possible. Otherwise, route conduit through the roof with pitch pocket. Conduit shall not penetrate ductwork. Exposed conduit shall not be installed on the roof without the ENGINEER's prior approval.
- D. Install conduit at elevations which maintain headroom, and at locations which avoid interference with other work requiring grading of pipe, the structure, finished walls, etc. Avoid crossing other work. Conduits shall not be placed in close proximity to equipment, systems, and service lines. Maintain a minimum of 3" separation, except in crossing which shall be a minimum of 1". Conduits shall not be installed/concealed in water bearing walls.
- E. Conduits in buildings shall be exposed on unfinished ceilings and basements, as shown on the plans. Rigidly support conduits to the building structures using hardware bolted or screwed to the structure. The mounting hardware shall not mount the conduit directly on concrete walls and ceilings, but shall space the conduit away from the surfaces using mineralac-type hardware, strut channel clamps, or one hole straps with clamp backs.
- F. Group conduit in parallel runs where practical. Use a conduit rack constructed of channels with conduit straps or clamps. Provide space for an additional 25% conduit.
- G. Parallel runs of conduit shall have bends and offsets made at the same point such that the angle of bend is the same in each conduit and the conduits remain parallel throughout the

run. Conduits not installed in this manner shall be removed and reinstalled at the Contractor's expense. Conductors that are installed shall be removed and replaced at the Contractor's expense.

- H. Conduits installed in parallel shall be arranged such that crossings are eliminated.
- I. Nuts, bolts, concrete anchor bolts and other metallic fasteners shall be 304L stainless steel.
- J. Install conduit with threaded couplings and other threaded fittings. Threadless, or clamp type fittings shall not be used on metallic conduit. Rigid aluminum conduit shall have each set of threads coated with an oxidation inhibitor.
- K. Use suitable conduit caps to protect installed conduit against entry of dirt and moisture. The use of duct tape or any other tape shall be prohibited.
- L. Use watertight hubs to fasten conduit to metal boxes, etc. in wet or damp locations per the National Electrical Code.
- M. Provide at least 1/4 inch air space between the back of boxes, equipment and the wall.
- N. Conduits terminating inside an air conditioned space from outside shall be sealed to prevent moisture/condensation from entering the enclosure.
- O. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
- P. Where applicable, aluminum conduit, straps, and struts shall not be in direct contact with concrete. Provide a neoprene washer between the two materials.
- Q. PVC conduit shall not be installed above grade level, above concrete slab level, or for any exposed installations unless specified.
- R. Conduit system shall be swabbed clean prior to installation of conductors.
- S. Ground conduits in accordance with the National Electrical Code and Specification 26 05 26, GROUNDING & BONDING FOR ELECTRICAL SYSTEMS.
- T. Install manufactured PVC coated aluminum conduit elbows for stub-ups at poles and equipment and at building entrances through floor. Encase elbows for stub-up ducts throughout length of elbow.
- U. Complete raceway installation before starting conductor installation.
- V. Cut conduit perpendicular to the length. For conduits 2" trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length.
- W. Comply with requirements in Section 26 05 29 "Hangers and Supports for Electrical Systems" for hangers and supports.
- X. Arrange stub-ups so curved portions of bends are not visible above finished slab.
- Y. Install no more than the equivalent of three 90-degree bends in any conduit run except for control wiring conduits, for which fewer bends are allowed. Support within 36 inches of changes in direction or where conduit penetrates through a floor, wall, or transitions from underground.

- Z. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.
- AA. Coat field-cut threads on PVC-coated raceway with a corrosion-preventing conductive compound prior to assembly.
- BB. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.
- CC. Install conduit drain assemblies in outside or underground conduits to provide for draining.
- DD. Where conduit elevations are higher than the penetration of a box, contractor will install a conduit drain before each termination.
- EE. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all raceways at the following points:
 - 1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
 - 2. Where an underground service raceway enters a building or structure.
 - 3. Where otherwise required by NFPA 70.
- FF. Comply with manufacturer's written instructions for solvent welding RNC and fittings.

3.03 CONDUITS THROUGH CONCRETE:

- A. Conduit shall not be placed horizontally in a concrete floor slab or a beam without the Engineer's written approval.
- B. Conduit stubbed-up through concrete and under free standing enclosures located indoors/outdoors, in an electrical room, etc., such as a motor control center, shall include an insulated throat grounding bushing threaded to the conduit termination.
- C. Conduit passing through concrete shall be PVC coated aluminum. Conduit shall extend 6" above concrete transition before the first fitting or enclosure, if the enclosure is not a floor mounted enclosure.
- D. Where conduit transitions from below concrete into a duct bank, the conduit shall be PVC coated aluminum to the elbow.
- E. Conduit extending into concrete shall not be closer than 3" from adjacent conduit and shall not be closer than 1" from any reinforcement bars.
- F. Where conduits stub up through a floor slab from below finished floor level for multi-level structures, install a threaded fitting with PVC plug so that the top of the fitting is flush with the concrete or finished floor surface.

3.04 RACEWAYS EMBEDDED IN SLABS:

- A. Run conduit larger than 1" trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure raceways to reinforcement at maximum 10-foot intervals.
- B. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
- C. Arrange raceways to keep a minimum of 2 inches of concrete cover in all directions.
- D. Do not embed threadless fittings in concrete unless specifically approved by Engineer for each specific location.

3.05 STUB-UPS TO ABOVE RECESSED CEILINGS:

- A. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.

3.06 SURFACE RACEWAY INSTALLATION

- A. Install surface raceway with a minimum 2" radius control at bend points.
- B. Secure surface raceway with screws or other anchor-type devices at intervals not exceeding 48 inches and with no less than two supports per straight raceway section. Support surface raceway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.

3.07 HAZARDOUS LOCATION CONDUIT INSTALLATION

- A. Install raceway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings according to NFPA 70.
 - 1. Sealing fittings shall be filled with compound rated for hazardous locations Class I, Div.2 for conduits leaving classified areas as indicated on the drawings.

3.08 EXPANSION FITTING INSTALLATION

- A. Expansion Fittings:
 - 1. Expansion fittings used with aluminum conduit shall be installed in the following locations:
 - a. At construction joints.
 - b. In conduit runs longer than 100'
 - c. Transitions from underground to above elevation (exposed).
 - 2. Install in each run of aboveground RMC conduit that is located where environmental temperature change may exceed 100 deg F and that has straight-run length that exceeds 100 feet.
 - 3. Install expansion fittings at all locations where conduits, concealed or surface mount, cross building, structure, construction and seismic expansion joints.

4. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.
5. Where conduits stub up from underground duct bank, install expansion fittings before the first channel strut secures conduit. Expansion fitting shall be at least 1.5' from the top of finish elevation and shall include a grounding strap.
6. Conduits transitioning from underground to be supported by a structure shall include an expansion fitting before the conduit is strapped at its first conduit support.

3.09 LIQUID TIGHT FLEXIBLE CONDUIT INSTALLATION

- A. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 72 inches of flexible conduit for equipment subject to vibration, noise transmission, or movement; and for transformers and motors.
 1. Use LFMC in damp or wet locations subject to severe physical damage.
 2. Use LFMC in damp or wet locations not subject to severe physical damage.

3.10 JUNCTION BOX AND PULL BOX INSTALLATION

- A. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements.
- B. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surfaces to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.
- C. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.
- D. Locate boxes so that cover or plate will not span different building finishes.
- E. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.
- F. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.
- G. Set metal floor boxes level and flush with finished floor surface.
- H. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.
- I. Field drilling holes in boxes to support the box shall not be allowed.

3.11 INSTALLATION OF UNDERGROUND CONDUIT

- A. Concrete Encased Conduit:
 1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Section 31 23 33, "Trenching and Backfill" for pipe less than 6 inches in nominal diameter.

2. Install backfill as specified in Section 31 23 33, "Trenching and Backfill."
3. After installing conduit and concrete, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Section 31 23 33 "Trenching and Backfill."
4. At the transition from underground and or from concrete, protect conduit from mechanical damage by extending PVC coated rigid aluminum conduit a maximum of 24" and a minimum of 4" into the earth or concrete at the transition.
 - a. Couple PVC coated aluminum conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete for a minimum of 12 inches on each side of the coupling.
5. Warning Marker: Set warning markers directly above concrete encased duct banks. Align markers along centerline of conduit.
 - a. Warning markers will:
 - 1). Be cast concrete 24"X24"X4".
 - 2). Include directional indication arrows.
 - 3). 3/8" depth, 2" high lettering shall be cast into the marker.
 - 4). Placed every 100' or at each duct bank direction change.
 - b. Power warning markers shall include:
 - 1). The following text "POWER DUCT BANK".
 - 2). Directional arrows.
 - c. Instrumentation, Communication, and Control markers shall include:
 - 1). The following text "I&C DUCT BANK".
 - 2). Directional arrows.
6. Underground Warning Tape: Comply with requirements in Section 26 05 53 "Identification for Electrical Systems."
7. For installation of conduits to be used by electric utility, coordinate with the utility for exact requirements
8. Conduit which is below the finished grade shall be PVC schedule 40, except where indicated on the plans or noted otherwise.
9. Bury underground conduit a minimum of 18" deep to the top of the concrete encasement for 600V duct banks and as shown on the plans, whichever is greater. Backfill buried conduit banks with material which is free from large rock, paving material, or large angular substance.

10. Install underground conduit with the conduit duct bank dimensions shown on the plans. Adhere to conduit spacing by using spacers at intervals to ensure that proper spacings are maintained.
11. The concrete shall be red in color. Apply dye in concrete truck, sprinkling dye on top of the duct bank after concrete placement is prohibited. Place 3" CMU blocks under rebar cage to suspend rebar off the bottom of the trench so that it does not contact the soil and is completely encased in the concrete envelope when concrete is placed.
12. Underground 2" and larger conduit bends shall have a long sweep bend radius.
13. Contractor shall install duct bank spacers a minimum of every 5 feet.
14. Elbows 1.5" and larger: PVC COATED ARC
15. Elbows below 1.5" where allowed: RNC, Type EPC-80-PVC

3.12 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

- A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.
- B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2" sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.
- C. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch above finished grade.
- D. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables but short enough to preserve adequate working clearances in enclosure.
- E. Field-cut openings for conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.
- F. Conduit terminations shall include end bell fittings cast into the duct bank pour. End bell fittings cut to fit conduit terminations after the duct bank pour is not acceptable. Contractor will be asked to remove conductors from raceway, install end bell, re-pull conductors, and megger conductors. Conductors failing megger tests will be replaced at the cost of the contractor.

3.13 SIZING AND INSTALLATION OF WIREWAYS, PULL BOXES AND JUNCTION BOXES

- A. The CONTRACTOR shall be responsible for providing and sizing all wireways, pull boxes and junction boxes per the National Electrical Code (NEC) Article 314 and all other relevant sections of the NEC.
- B. Install Products in accordance with manufacturer's instructions.
- C. Use screws, clips, and straps to fasten raceway channel to surfaces. Mount plumb and level.
- D. Use suitable insulating bushings and inserts at connections to outlets and corner fittings.

- E. Wireway Supports: Per manufacturer's recommendations. The Contractor shall support the wireway rigidly to the building structures using hardware bolted or screwed to the structure. Supporting wireways from corrugated metal structures shall not be allowed.
- F. Close ends of wireway and unused conduit openings.
- G. Use separate pull boxes and junction boxes for electric power, control and communication systems.
- H. Install pull boxes in interior conduit at not more than 100' apart when conduit runs are not broken by junction or outlet boxes.
- I. Pull and junction boxes shall be accessible and not buried.
- J. Do not install boxes back to back in walls and provide a minimum of 6" separation, except in acoustic-rated walls, provide 24" separation.
- K. Support boxes independently of conduit except for cast boxes that is connected to two rigid metal conduits, both supported within 12" of box.
- L. Box shall be mounted using mounting lugs. Drilling through the box to mount is prohibited. Any box drilled to mount will be rejected and shall be removed and replaced at the Contractor's expense.

3.14 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies.
- B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.
- C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
- D. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.
- E. Cut sleeves to length for mounting flush with both surfaces of walls.
- F. Extend sleeves installed in floors 2 inches above finished floor level.
- G. Size pipe sleeves to provide 1/4" annular clear space between sleeve and raceway unless sleeve seal is to be installed.
- H. Seal space outside of sleeves with grout for penetrations of concrete and masonry
- I. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway, using joint sealant appropriate for size, depth, and location of joint. Refer to Division 07 Section "Joint Sealants" for materials and installation.
- J. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway penetrations. Install sleeves and seal with firestop materials.
- K. Roof-Penetration Sleeves: Seal penetration of individual raceways with flexible, boot-type flashing units applied in coordination with roofing work.

- L. Aboveground, Exterior-Wall Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1" annular clear space between pipe and sleeve for installing mechanical sleeve seals.

3.15 FIRESTOPPING

- A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 07 84 13 "Penetration Firestopping."

3.16 PROTECTION

- A. Protect coatings, finishes, and cabinets from damage and deterioration.
 - 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
 - 2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

3.17 CONDUIT TERMINATIONS

- A. Conduit terminations at enclosures shall maintain the NEMA rating of the enclosure. Conduit terminations damaging enclosures shall not be permitted. Damaged enclosures will not be accepted and shall be replaced at the contractor's expense.
- B. Use grounding myers hubs for termination of conduits into enclosures.
- C. Locknut termination of conduits shall not be used on this project except where liquid tight fittings require locknuts to maintain UL listings. Locations utilizing liquid tight fittings shall include a stainless steel banded sealing gasket. Damaged bands or gaskets due to overtightening shall be replaced by the contractor.
- D. For exterior, wet locations, and where conduit enters from exterior or wet locations, conduit terminations shall not penetrate the top of enclosures. Enclosures with top penetrations shall be removed and replaced with conduits re-routed for side or bottom penetration at contractor's expense. If conductors have been installed and are too short to accommodate the re-routed conduit, then they shall be removed and replaced at the Contractor's expense.
- E. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors including conductors smaller than No. 4 AWG.
- F. Use suitable conduit caps to protect installed conduit against entry of dirt and moisture. The use of duct tape or any other tape shall be prohibited.
- G. Conduits terminating inside an air conditioned space from outside shall be sealed to prevent moisture/condensation from entering the enclosure.
- H. Where locknuts are allowed, do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.

3.18 JUNCTION BOX INSTALLATION

- A. Junction boxes shall be installed so they are accessible from the front.

- B. Junction boxes shall have terminal strips/distribution blocks for splicing conductors where approved by the ENGINEER or as shown/specified on the plans. Terminal strips shall be manufactured by Allen-Bradley, Phoenix Contact or approved equal. Distribution blocks shall be per Section 26 05 19.01, WIRE CONNECTIONS AND DEVICES. No top entry in junction boxes with a terminal strip.
- C. Use watertight hubs to fasten conduit to metal boxes, etc. in wet or damp locations per the National Electrical Code.
- D. Metallic Junction boxes shall be grounded with NEC approved grounding fasteners and by means allowed by the enclosure manufacturer. Enclosures drilled for grounding fasteners that do not meet code shall be replaced at the cost of the contractor.

END OF SECTION

26 05 53 IDENTIFICATION FOR ELECTRICAL SYSTEMS

1.00 GENERAL

1.01 WORK INCLUDED

A. Section Includes:

1. Identification for raceways.
2. Identification of power and control cables.
3. Identification for conductors.
4. Underground-line warning tape.
5. Warning labels and signs.
6. Instruction signs.
7. Equipment identification labels.
8. Miscellaneous identification products.

1.02 SUBMITTALS

- A. Shop drawings: For each electrical identification product indicated.

1.03 QUALITY ASSURANCE

- A. Comply with ANSI A13.1
- B. Comply with NFPA 70.
- C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.
- D. Comply with ANSI Z535.4 for safety signs and labels.
- E. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

2.00 PRODUCTS

2.01 POWER AND CONTROL CABLE IDENTIFICATION MATERIALS

- A. Circuits shall be tagged at terminations (both ends), in pull boxes, manholes, cabinets, and enclosures as follows:
1. Tags relying on adhesives or tapes-on markers are not acceptable.
 2. Provide conductor tags for conductors No. 10 AWG and below with legible permanent sleeve of yellow or white PVC with machine printed black marking, Raychem TMS sleeves or approved equal.
 3. Provide tags for cables and for conductors No. 8 AWG and larger consisting of permanent nylon marker plates with legible designations hot stamped on the plate. Attach these marker plates to conductors and cables with plastic wire wraps. Tags shall be Raychem TMS-CM cable markers or approved equal.

4. Metal tags shall be imprinted with panelboard and panelboard position number (e.g. LA3-23) for conductors fed from panelboards. Other conductors shall have tags imprinted with the MCC which feeds the conductors (e.g. MCC 1).
 5. Switchlegs shall have the designation described above on their tags, plus an "S" suffix. Travelers shall have the designation described above on their tags, plus a "T" suffix.
 6. Where more than one neutral is present with a group of conductors, a tag shall be applied to each neutral indicating which phase conductors are served by each neutral (e.g. HA-2, 4, 6).
- B. Wire tag termination names shall identify the circuit number, instrument tag number, and the control function along with the name indicated on the drawings.

2.02 CONDUCTOR IDENTIFICATION MATERIALS FOR POWER CONDUCTORS

- A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils thick by 1 to 2 inches wide.

2.03 UNDERGROUND-LINE WARNING TAPE

- A. Tape:
1. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines.
 2. Printing on tape shall be permanent and shall not be damaged by burial operations.
 3. Tape material and ink shall be chemically inert, and not subject to degrading when exposed to acids, alkalis, and other destructive substances commonly found in soils.
- B. Color and Printing:
1. Comply with ANSI Z535.1 through ANSI Z535.5.
 2. Inscriptions for Red-Colored Tapes: ELECTRIC LINE, HIGH VOLTAGE,
 3. Inscriptions for Orange-Colored Tapes: TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE.

2.04 WARNING LABELS AND SIGNS

- A. Comply with NFPA 70 and 29 CFR 1910.145.
- B. Self-Adhesive Warning Labels: Factory-printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment unless otherwise indicated.
- C. Baked-Enamel Warning Signs:
1. Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application.
 2. 1/4-inch grommets in corners for mounting.
 3. Nominal size, 7 by 10 inches.

D. Metal-Backed, Butyrate Warning Signs:

1. Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch galvanized-steel backing; and with colors, legend, and size required for application.
2. 1/4-inch grommets in corners for mounting.
3. Nominal size, 10 by 14 inches.

E. Warning label and sign shall include, but are not limited to, the following:

1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES." Sign shall indicate location of power sources.
 - a. Locations for multiple power source signs are:
 - 1). Influent Pump Station Electrical Building.
 - 2). Influent Pump Station Dumpster Building.
 - 3). Headworks Dumpster Building.
 - 4). RAS/WAS Pump Stations No. 1 and No. 2.
 - 5). RAS/WAS Electrical Building.
 - 6). UV Electrical Building.
2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES."
 - a. Locations for Workspace Clearing Warning signs:
 - 1). All locations where electrical equipment is installed.
3. Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD – HIGH VOLTAGE EQUIPMENT."
 - a. Locations for Power Source Warning signs:
 - 1). All locations where electrical equipment is installed.

2.05 INSTRUCTION SIGNS

- A. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch thick for signs up to 20 sq. inches and 1/8 inch thick for larger sizes.
1. Engraved legend with white letters on black face.
 2. Punched or drilled for 316 stainless steel screws and washers.

2.06 EQUIPMENT IDENTIFICATION LABELS

- A. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting. White letters on a dark-gray background. Minimum letter height shall be 3/8 inch.
- B. Instrumentation shall be tagged with Pan-Steel 316 stainless steel plates affixed to the instrument with 316 stainless steel wire.

2.07 CONDUIT AND RACEWAY TAGS

- A. Pan-steel 316 stainless steel plates, tags, and cable ties affixed to the conduit in two places.
- B. Tag shall identify the location of the other end of the conduit and identify if the conduit is used for control, communications, or power conductors.

3.00 EXECUTION

3.01 INSTALLATION

- A. Verify identity of each item before installing identification products.
- B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.
- C. Apply identification devices to surfaces that require finish after completing finish work.
- D. Attach signs and plastic labels that are not self-adhesive type with stainless steel mechanical fasteners appropriate to the location and substrate.
- E. Aluminum Wraparound Marker Labels and Metal Tags: Secure tight to surface of conductor or cable at a location with high visibility and accessibility.
- F. Cable Ties: For attaching tags. Use general-purpose type, except as listed below:
 - 1. Outdoors: 316 stainless steel wire.
- G. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 6 to 8 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches overall.

3.02 IDENTIFICATION SCHEDULE

- A. Accessible Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive vinyl labels with the wiring system legend and system voltage. System legends shall be as follows:
 - 1. Power.
 - 2. Controls.
- B. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use color-coding conductor tape to identify the phase.
 - 1. Color-Coding for Phase and Voltage Level Identification, 600 V or Less: Use colors listed below for ungrounded service, feeder and branch-circuit conductors.
 - a. Color shall be field applied for sizes larger than No. 8 AWG.
 - b. Colors for 208Y/120-V Circuits:
 - 1). Phase A: Black.
 - 2). Phase B: Red.
 - 3). Phase C: Blue.
 - 4). Neutral: White

- c. Colors for 480Y/277-V Circuits:
 - 1). Phase A: Purple.
 - 2). Phase B: Brown.
 - 3). Phase C: Yellow.
- d. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.
- C. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.
 - 1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
 - 2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
 - 3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual.
- D. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring.
 - 1. Install underground-line warning tape for both direct-buried cables and cables in raceway.
- E. Workspace Indication: Install floor marking tape to show working clearances in the direction of access to live parts. Workspace shall be as required by NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.
 - 1. Tripping hazards shall be labelled.
- F. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-adhesive warning labels.
 - 1. Comply with 29 CFR 1910.145.
 - 2. Identify system voltage with black letters on an orange background.
 - 3. Apply to exterior of door, cover, or other access.
 - 4. For equipment with multiple power or control sources, apply to door or cover of equipment including, but not limited to, the following:
 - a. Power transfer switches.
 - b. Controls with external control power connections.
 - c. 480V power enclosures.
- G. Emergency Operating Instruction Signs: Install instruction signs with white legend on a red background with minimum 3/8-inch high letters for emergency instructions at equipment used for power transfer.

- H. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and the Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.

1. Labeling Instructions:

- a. Indoor Equipment: Self-adhesive, engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with 1/2-inch high letters on 1-1/2-inch high label; where two lines of text are required, use labels 2 inches high.
- b. Outdoor Equipment: Engraved, laminated acrylic or melamine label 4 inches high.
- c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
- d. Unless provided with self-adhesive means of attachment, fasten labels with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure.

2. Equipment to Be Labeled:

- a. Panelboards: Typewritten directory of circuits in the location provided by panelboard manufacturer. Panelboard identification shall be self-adhesive, engraved, laminated acrylic or melamine label.
- b. Enclosures and electrical cabinets.
- c. Access doors and panels for concealed electrical items.
- d. Switchgear.
- e. Switchboards.
- f. Transformers: Label that includes tag designation shown on Drawings for the transformer, feeder, and panelboards or equipment supplied by the secondary.
- g. Emergency system boxes and enclosures.
- h. Motor-control centers.
- i. Enclosed switches.
- j. Enclosed circuit breakers.
- k. Enclosed controllers.
- l. Variable-speed controllers.
- m. Push-button stations.
- n. Power transfer equipment.
- o. Contactors.
- p. Remote-controlled switches, dimmer modules, and control devices.
- q. Monitoring and control equipment.

END OF SECTION

26 22 13 LOW-VOLTAGE DISTRIBUTION TRANSFORMERS

1.00 GENERAL

1.01 SUMMARY

- A. Section includes distribution, dry-type transformers with a nominal primary and secondary rating of 600 V and less, with capacities up to 1500 kVA.

1.02 SUBMITTALS

- A. Shop Drawings:
 - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment.
 - 3. Include diagrams for power, signal, and control wiring.
- B. Operation and Maintenance Data: For transformers to include in emergency, operation, and maintenance manuals.

1.03 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Accredited by NETA.
 - 1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Inspection: On receipt, inspect for and note any shipping damage to packaging and transformer.
 - 1. If manufacturer packaging is removed for inspection, and transformer will be stored after inspection, re-package transformer using original or new packaging materials that provide protection equivalent to manufacturer's packaging.
- B. Storage: Store in a warm, dry, and temperature-stable location in original shipping packaging.
- C. Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit, throughout periods during which equipment is not energized and when transformer is not in a space that is continuously under normal control of temperature and humidity.
- D. Handling: Follow manufacturer's instructions for lifting and transporting transformers.

2.00 PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements:

1. ABB (Electrification Products Division).
 2. Eaton.
 3. Schneider Electric USA (Square D).
 4. Siemens Industry, Inc., Energy Management Division.
 5. Approved equal.
- B. Source Limitations: Obtain each transformer type from single source from single manufacturer.

2.02 GENERAL TRANSFORMER REQUIREMENTS

- A. Description: Factory-assembled and -tested, air-cooled units for 60-Hz service.
- B. Comply with NFPA 70.
1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
- C. Transformers Rated 15 kVA and Larger:
1. Comply with 10 CFR 431 (DOE 2016) efficiency levels.
 2. Marked as compliant with DOE 2016 efficiency levels by an NRTL.
- D. Shipping Restraints: Paint or otherwise color-code bolts, wedges, blocks, and other restraints that are to be removed after installation and before energizing. Use fluorescent colors that are easily identifiable inside the transformer enclosure.

2.03 DISTRIBUTION TRANSFORMERS

- A. Comply with NFPA 70.
- B. Cores: Electrical grade, non-aging silicon steel with high permeability and low hysteresis losses.
1. One leg per phase.
 2. Core volume shall allow efficient transformer operation at 10 percent above the nominal tap voltage.
 3. Grounded to enclosure.
- C. Coils: Continuous windings without splices except for taps.
1. Coil Material: Copper.
 2. Internal Coil Connections: Brazed or pressure type.
 3. Terminal Connections: Bolted.
- D. Encapsulation: Transformers smaller than 30 kVA shall have core and coils completely resin encapsulated.
- E. Enclosure: Ventilated.
1. NEMA 250, Type 2: Core and coil shall be encapsulated within resin compound to seal out moisture and air. Type 3R for outdoor locations.

2. KVA Ratings: Based on convection cooling only and not relying on auxiliary fans.
 3. Wiring Compartment: Sized for conduit entry and wiring installation.
- F. Enclosure: Totally enclosed, nonventilated.
1. NEMA 250, Type 4X, Stainless Steel: Core and coil shall be encapsulated within resin compound to seal out moisture and air.
 2. KVA Ratings: Based on convection cooling only and not relying on auxiliary fans.
 3. Wiring Compartment: Sized for conduit entry and wiring installation.
- G. Taps for Transformers 3 kVA and Smaller: None.
- H. Taps for Transformers 7.5 to 24 kVA: One 5 percent tap above and one 5 percent tap below normal full capacity.
- I. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and two 2.5 percent taps below normal full capacity.
- J. Insulation Class, Smaller Than 30 kVA: 180 deg C, UL-component-recognized insulation system with a maximum of 115 deg C rise above 40 deg C ambient temperature.
- K. Insulation Class, 30 kVA and Larger: 220 deg C, UL-component-recognized insulation system with a maximum of 115 deg C rise above 40 deg C ambient temperature.
- L. Grounding: Provide ground-bar kit or a ground bar installed on the inside of the transformer enclosure.
- M. Provide bird screen for outdoor transformers.

2.04 IDENTIFICATION

- A. Nameplates: Engraved, laminated-acrylic or melamine plastic signs for each distribution transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Section 26 05 53 "Identification for Electrical Systems."

2.05 SOURCE QUALITY CONTROL

- A. Test and inspect transformers according to IEEE C57.12.01 and IEEE C57.12.91.
1. Resistance measurements of all windings at rated voltage connections and at all tap connections.
 2. Ratio tests at rated voltage connections and at all tap connections.
 3. Phase relation and polarity tests at rated voltage connections.
 4. No load losses, and excitation current and rated voltage at rated voltage connections.
 5. Impedance and load losses at rated current and rated frequency at rated voltage connections.
 6. Applied and induced tensile tests.
 7. Regulation and efficiency at rated load and voltage.
 8. Insulation-Resistance Tests:

- a. High-voltage to ground.
 - b. Low-voltage to ground.
 - c. High-voltage to low-voltage.
9. Temperature tests.

3.00 EXECUTION

3.01 EXAMINATION

- A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each transformer.
- B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.
- C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.
- D. Verify that ground connections are in place and requirements in Section 26 05 26 "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at location of transformer.
- E. Environment: Enclosures shall be rated for the environment in which they are located. Covers for NEMA 250, Type 4X enclosures shall not cause accessibility problems.
- F. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Install wall-mounted transformers level and plumb with wall brackets fabricated by transformer manufacturer.
 - 1. Coordinate installation of wall-mounted and structure-hanging supports with actual transformer provided.
- B. Install transformers level and plumb on a concrete base with vibration-dampening supports. Locate transformers away from corners and not parallel to adjacent wall surface.
- C. Construct concrete bases according to Section 03 30 00 "Cast-in-Place Concrete" and anchor floor-mounted transformers according to manufacturer's written instructions and requirements in Section 26 05 29 "Hangers and Supports for Electrical Systems."
 - 1. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.
- D. Secure transformer to concrete base according to manufacturer's written instructions.
- E. Secure covers to enclosure and tighten all bolts to manufacturer-recommended torques to reduce noise generation.
- F. Remove shipping bolts, blocking, and wedges.

3.03 CONNECTIONS

- A. Ground equipment according to Section 26 05 26 "Grounding and Bonding for Electrical Systems."
- B. Connect wiring according to Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."
- C. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.
- D. Provide flexible connections at all conduit and conductor terminations and supports to eliminate sound and vibration transmission to the building structure.

3.04 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Small (Up to 167-kVA Single-Phase or 500-kVA Three-Phase) Dry-Type Transformer Field Tests:
 - 1. Visual and Mechanical Inspection.
 - a. Inspect physical and mechanical condition.
 - b. Inspect anchorage, alignment, and grounding.
 - c. Verify that resilient mounts are free and that any shipping brackets have been removed.
 - d. Verify the unit is clean.
 - e. Perform specific inspections and mechanical tests recommended by manufacturer.
 - f. Verify that as-left tap connections are as specified.
 - g. Verify the presence of surge arresters and that their ratings are as specified.
 - 2. Electrical Tests:
 - a. Measure resistance at each winding, tap, and bolted connection.
 - b. Perform insulation-resistance tests winding-to-winding and each winding-to-ground. Apply voltage according to manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.5. Calculate polarization index: the value of the index shall not be less than 1.0.
 - c. Perform turns-ratio tests at all tap positions. Test results shall not deviate by more than one-half percent from either the adjacent coils or the calculated ratio. If test fails, replace the transformer.
 - d. Verify correct secondary voltage, phase-to-phase and phase-to-neutral, after energization and prior to loading.
- C. Large (Larger Than 167-kVA Single Phase or 500-kVA Three Phase) Dry-Type Transformer Field Tests:
 - 1. Visual and Mechanical Inspection:

- a. Inspect physical and mechanical condition.
 - b. Inspect anchorage, alignment, and grounding.
 - c. Verify that resilient mounts are free and that any shipping brackets have been removed.
 - d. Verify the unit is clean.
 - e. Perform specific inspections and mechanical tests recommended by manufacturer.
 - f. Verify that as-left tap connections are as specified.
 - g. Verify the presence of surge arresters and that their ratings are as specified.
2. Electrical Tests:
- a. Measure resistance at each winding, tap, and bolted connection.
 - b. Perform insulation-resistance tests winding-to-winding and each winding-to-ground. Apply voltage according to manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.5. Calculate polarization index: the value of the index shall not be less than 1.0.
 - c. Perform power-factor or dissipation-factor tests on all windings.
 - d. Perform turns-ratio tests at all tap positions. Test results shall not deviate by more than one-half percent from either the adjacent coils or the calculated ratio. If test fails, replace the transformer.
 - e. Perform an excitation-current test on each phase.
 - f. Perform an applied voltage test on all high- and low-voltage windings to ground. See IEEE C57.12.91, Sections 10.2 and 10.9.
 - g. Verify correct secondary voltage, phase-to-phase and phase-to-neutral, after energization and prior to loading.
- D. Remove and replace units that do not pass tests or inspections and retest as specified above.
- E. Infrared Scanning: Two months after Substantial Completion, perform an infrared scan of transformer connections.
- 1. Use an infrared-scanning device designed to measure temperature or detect significant deviations from normal values. Provide documentation of device calibration.
 - 2. Perform two follow-up infrared scans of transformers, one at four months and the other at 11 months after Substantial Completion.
 - 3. Prepare a certified report identifying transformer checked and describing results of scanning. Include notation of deficiencies detected, remedial action taken, and scanning observations after remedial action.
- F. Test Labeling: On completion of satisfactory testing of each unit, attach a dated and signed "Satisfactory Test" label to tested component.

3.05 ADJUSTING

- A. Record transformer secondary voltage at each unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 5 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.
- B. Output Settings Report: Prepare a written report recording output voltages and tap settings.

3.06 CLEANING

- A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

END OF SECTION

26 24 16 PANELBOARDS

1.00 GENERAL

1.01 WORK INCLUDED

A. Section Includes:

1. Distribution panelboards.
2. Lighting and appliance branch-circuit panelboards.
3. Load centers.
4. Electronic-grade panelboards.

1.02 DEFINITIONS

- A. SVR: Suppressed voltage rating.
- B. SPD: Surge Protection Device

1.03 SUBMITTALS

- A. Product Data: For each type of panelboard, switching and overcurrent protective device, surge protection device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
- B. Shop Drawings: For each panelboard and related equipment.
1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.
 2. Detail enclosure types and details for types other than NEMA 250, Type 1.
 3. Detail bus configuration, current, and voltage ratings.
 4. Short-circuit current rating of panelboards and overcurrent protective devices.
 5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
 6. Include wiring diagrams for power, signal, and control wiring.
 7. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.
- C. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
 2. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

1.04 QUALITY ASSURANCE

- A. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.
- B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- C. Comply with NEMA PB 1.
- D. Comply with NFPA 70.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (250 W per panelboard) to prevent condensation.
- B. Handle and prepare panelboards for installation according to NEMA PB 1.

1.06 PROJECT CONDITIONS

- A. Environmental Limitations:
 - 1. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 - a. Ambient Temperature: Not exceeding 23 deg F to plus 110 deg F.
 - b. Altitude: Not exceeding 1000 feet.

1.07 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: Five years from date of Substantial Completion.

1.08 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Keys: Two spares for each type of panelboard cabinet lock.

2.00 PRODUCTS

2.01 GENERAL REQUIREMENTS FOR PANELBOARDS

- A. Enclosures: Surface mounted cabinets.
 - 1. Rated for environmental conditions at installed location.
 - a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
 - b. Outdoor, Corrosive or Wash-Down Areas: NEMA 250, Type 4X 304 stainless steel.

- c. Other Wet or Damp Indoor Locations: NEMA 250, Type 4X 304 stainless steel.
- 2. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box.
- 3. Skirt for Surface-Mounted Panelboards: Same gage and finish as panelboard front with flanges for attachment to panelboard, wall, and ceiling or floor.
- 4. Gutter Extension and Barrier: Same gage and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panel sections.
- 5. Finishes:
 - a. Panels and Trim (that are not stainless steel): Steel factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
 - b. Back Boxes: Same finish as panels and trim.
- 6. Directory Card: Inside panelboard door, mounted in metal frame with transparent protective cover.
- B. Incoming Mains Location: Top and bottom.
- C. Phase, Neutral, and Ground Buses:
 - 1. Material: Hard-drawn copper, 98 percent conductivity.
 - 2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
 - 3. Isolated Ground Bus: Adequate for branch-circuit isolated ground conductors; insulated from box.
 - 4. Extra-Capacity Neutral Bus: Neutral bus rated 200 percent of phase bus and UL listed as suitable for nonlinear loads.
 - 5. Split Bus: Vertical buses divided into individual vertical sections.
- D. Conductor Connectors: Suitable for use with conductor material and sizes.
- E. Service Equipment Label: NRTL labeled for use as service equipment for panelboards or load centers with one or more main service disconnecting and overcurrent protective devices.
- F. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals.
- G. Circuit breakers shall be equipped with individually insulated, braced and protected connectors to the main bus. The front surface of all circuit breakers shall be flush with each other. Permanent, individual circuit numbers shall be affixed to each breaker in a common position. Tripped indication shall be clearly indicated by the breaker handle between the "ON" and "OFF" position. Space positions indicated on the plans shall be so that the additional connectors or bus will not be required to add breakers.
- H. Each panelboard shall have a short circuit current rating equal to or greater than the fault current available at each panel. Series rating of breakers shall not be permitted.

Panelboards shall be marked with their maximum short circuit current rating at the supply voltage and bear the applicable U.L. label.

2.02 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product by one of the following:
 - 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 - 3. Square D; a brand of Schneider Electric.
 - 4. No others approved
- B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.
- C. Mains: Circuit breaker.
- D. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.
- E. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.
- F. Column-Type Panelboards: Narrow gutter extension, with cover, to overhead junction box equipped with ground and neutral terminal buses.
- G. Full size Neutral bus bar.
- H. Grounding bus bar.

2.03 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product by one of the following:
 - 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 - 3. Square D; a brand of Schneider Electric.
 - 4. No others approved.
- B. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.
 - 1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
 - 2. GFCI Circuit Breakers: Single and two-pole configurations with Class A ground-fault protection (6-mA trip).
 - 3. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
 - a. Standard frame sizes, trip ratings, and number of poles.

- b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
- c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
- d. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.

2.04 PANELBOARD SUPPRESSORS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product by one of the following:
 - 1. Current Technology; a subsidiary of Danahar Corporation.
 - 2. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - 3. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 - 4. Liebert Corporation.
 - 5. Square D; a brand of Schneider Electric.
 - 6. No others approved.
- B. Surge Protection Device: IEEE C62.41-compliant, integrally mounted, wired-in, solidstate, parallel-connected, modular (with field-replaceable modules type, with sine-wave tracking suppression and filtering modules, UL 1449, second edition, short-circuit current rating matching or exceeding the panelboard short-circuit rating, and with the following features and accessories:
 - 1. Accessories:
 - a. Fabrication using bolted mechanical lugs for internal wiring.

2.05 ACCESSORY COMPONENTS AND FEATURES

- A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

3.00 EXECUTION

3.01 EXAMINATION

- A. Receive, inspect, handle, and store panelboards according to NEMA PB 1.1.
- B. Examine panelboards before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.
- C. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Install panelboards and accessories according to NEMA PB 1.1.
- B. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.
- C. Mount top of trim no higher than 90 inches above finished floor unless otherwise indicated.
- D. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.
- E. Install overcurrent protective devices and controllers not already factory installed.
 - 1. Set field-adjustable, circuit-breaker trip ranges.
- F. Install filler plates in unused spaces.
- G. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.
- H. Comply with NECA 1.

3.03 IDENTIFICATION

- A. Create a directory to indicate installed circuit loads after balancing panelboard loads; incorporate Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.
- B. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."
- C. Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

3.04 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- B. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- C. Acceptance Testing Preparation:
 - 1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.

D. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

E. Panelboards will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.05 ADJUSTING

A. Adjust moving parts and operable component to function smoothly and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as specified in Division 26 Section "Overcurrent Protective Device Coordination Study."

C. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes.

1. Measure as directed during period of normal system loading.
2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical 24-hour services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.
4. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.

3.06 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions.

END OF SECTION

**CITY OF BEAUMONT
DEPARTMENT OF PUBLIC WORKS
WATER UTILITIES**

**PRE-BID CONFERENCE FOR THE
Pine Street SWTP Polymer System and Chemical Storage Tank Improvements
Bid No. WU0122-12**

Date: February 23rd, 2022 @ 1:30 P.M.

NOTE: Whatever is said during this meeting is meant to be helpful but does not and cannot change the Bid Documents. Bidders must rely on published Addenda for official answers to written questions that are not currently covered by Bid Documents.

1. CITY'S PROJECT TEAM:

The City's project team consists of the following:

- Department of Public Works Director: Bart Bartkowiak
- Capital Projects Administrator: Dara Woodruff
- Project Manager: Blake Fredieu
- Construction Manager/Inspector: Blain Dishman
- City's Design Firm: Freese and Nichols

2. SCOPE OF WORK

- The Contractor will perform the modifications to the bulk chemical storage facility, and the chemical feed building tasks as following, noted and in accordance with the details provided in this project manual or as directed by the Engineer on: Pine Street SWTP Polymer System and Chemical Storage Tank Improvements.
- The work generally includes:
 - Demolition of tanks, emergency eyewash/showers, and associated piping and appurtenances etc.
 - Construction of concrete storage bays with ladders, sumps, and tank pads etc.
 - Demolition and replacement of ammonia day tank and associated piping and appurtenances.

3. Bids:

- A. Bids shall be received at the City Clerk's office by 2:00 P.M. Thursday, March 3rd, 2022 at Room 125 (First Floor) of City Hall.
- B. Forms to be completed and submitted with bids:
 - a. Required Forms Checklist (00 21 14)
 - b. Bid (00 41 13)
 - c. Bid Schedule (00 41 16)
 - d. Bid Summary (00 41 17)
- C. Corporate Resolution (00 73 48)
 - a. Bid Bond (00 43 16)
 - b. Conflict of Interest Questionnaire (00 45 03)
 - c. Statement of City Charter on COI (00 73 47)
 - d. Insurance Requirement Affidavit (00 73 16.1)

- e. Schedule of MBE Participation (00 73 50.1)
- D. Bidders are responsible for obtaining Addenda, which can be downloaded from the City's website or Civcast.
- E. If a bid is submitted without the listed forms, the City reserves the right to deem the bidder as non-responsive.
- F. Bid includes Eleven (11) Base Bid Items.

4. ADDITIONAL REQUIRED FORMS AND INSURANCE:

- A. City of Beaumont gives preference to Local Bidders.
- B. Review insurance requirements.
- C. The City of Beaumont is committed to encouraging and promoting the use of Minority Business Enterprises (MBE) in construction contracts. The goal is to use 20%.

5. AGREEMENT AND BONDS:

- A. Review Agreement (00 52 13)
- B. Time allowed for work: 270 calendar days (M-F, 7-5, unless otherwise approved in writing)
- C. Contractor required to obtain Performance Bond (00 61 13) and Payment Bond (00 61 16)
- D. Contractor will be issued a Notice of Award (00 70 01) and will submit Post-Award documents
- E. Contractor will be issued a Notice to Proceed (00 70 02)

6. CONTRACT CONDITIONS

- A. General Conditions (Division 1 – 01 11 00 – Division 46 – 46 33 41)

7. GENERAL REQUIREMENTS

- A. Utilizing Jefferson County, Texas Highway Wage Rates (00 21 13-7)

8. PROJECT TECHNICAL SPECIFICATIONS:(PAGES 02 41 00 – 46 33 41)

9. QUESTIONS AND COMMENTS:

- A. Questions and comments regarding the information provided in this Pre-Bid Meeting?
- B. Questions and comments will be received until 5:00 P.M. on Friday, February 25th, 2022. Please direct all questions to the Project Manager. You may reach Mr. Fredieu at blake.fredieu@beaumonttexas.gov or by phone at 409-785-3006.